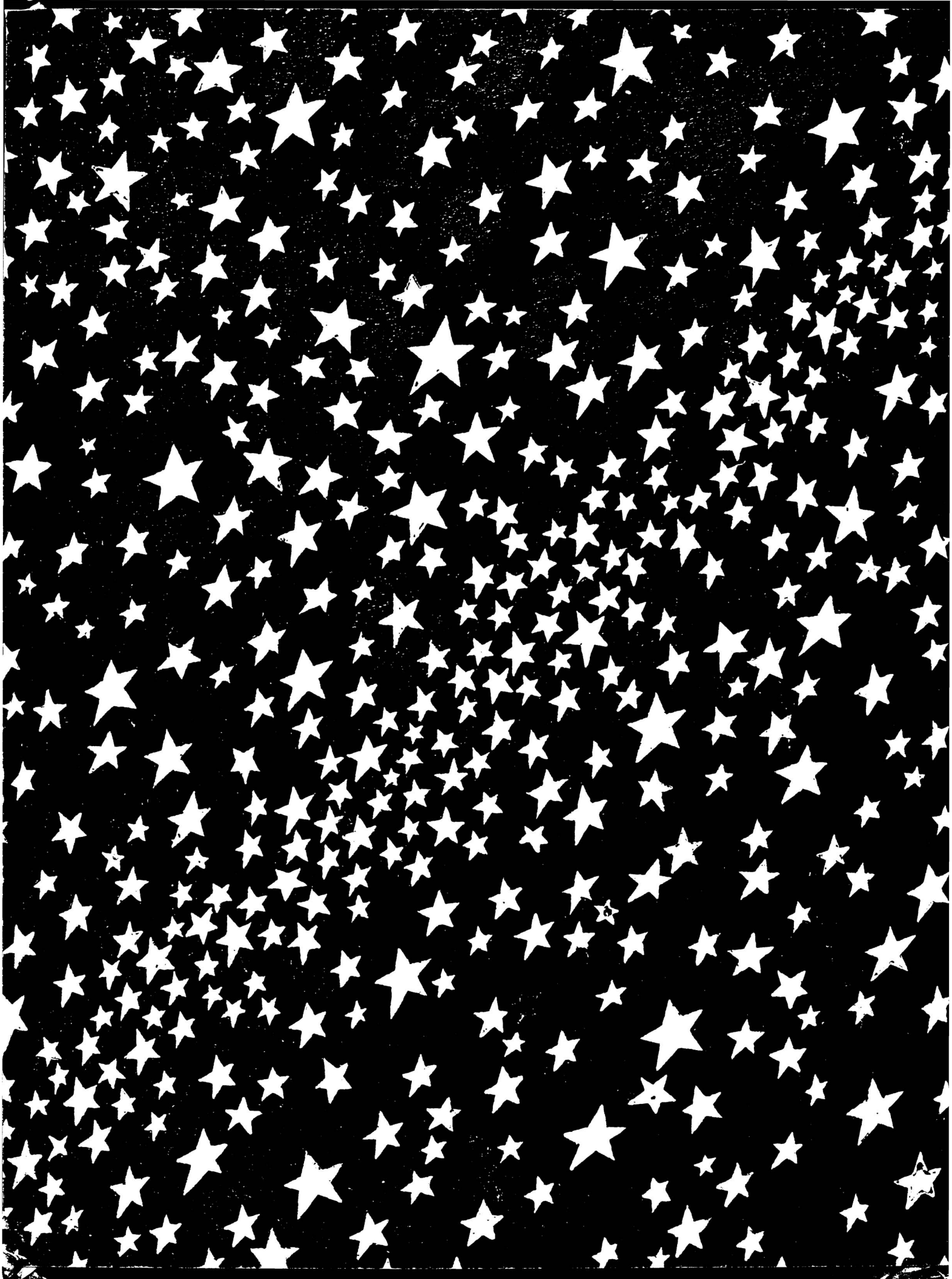




Pavel Klushantsev

**ALL ABOUT
THE
TELESCOPE**



Translated from the Russian by *Jan Butler*
Illustrated by *E. Voishvillo, B. Kalaushin, and B. Starodubtsev*
Designed by *Y. Kiselyov*

Surely, you'd like to know where the Earth ends, what surrounds the Earth, how far it is to the Moon and the stars, why the stars sparkle, why a ball you throw up always falls down, why it's warmer in the Sun in summer, why the Moon is round one day and crescent-shaped another, and what other planets there are besides the Earth.

The answers to these and many other questions are contained in P. Klushantsev's book *All About the Telescope*

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Pavel Klushantsev



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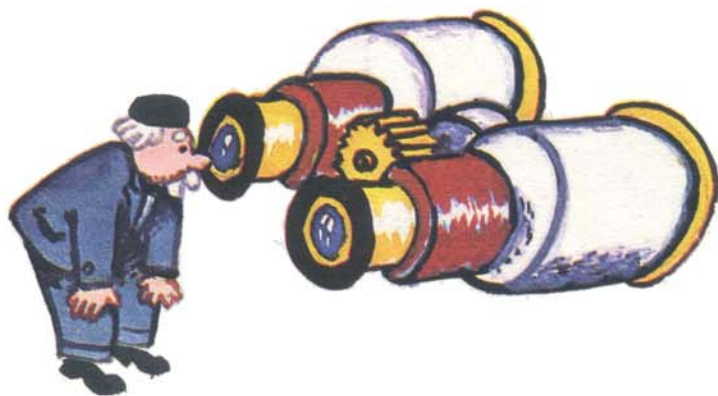




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Where Does the World End?

How fine it is in a field in summer! The air is fresh and smells of flowers and you can see for miles around. And if you run up a hill you can see even further: the end of the field, a dark forest by a shimmering lake and a winding road. Further still there is another field and perhaps more forests, roads, lakes, rivers and towns.

The Earth really does seem like a huge flat saucer, doesn't it? And this saucer is covered by the sky like a vast ceiling. In the day this ceiling is blue and at night it is black and the stars blaze in it like distant lights.

The ceiling in a theatre is large but the sky is, of course, infinitely wider and higher.

The ceiling seems round like a large dome whose edges touch the flat saucer and if you travel a very long way across the Earth in one direction, you'll most likely reach the place where "Earth meets sky". This is how it happened in the tale about the Little Humpbacked Horse*:

* P. Yershov, *The Little Humpbacked Horse*, Moscow, 1976, p. 74.

*"Near or far, or high or low,
How they travelled, I don't know...
Only, brothers, I did hear
(Indirectly, though, I fear)
That the humpback came to where
Earth meets sky; and it is there,
Peasant maidens, spinning flax,
Use the clouds as distaff racks.
Bidding Mother Earth good-bye,
Vanya rode up to the sky;
Like a prince, he proudly flew
Through the skies, his hat askew."*

If only this were possible! You'd just walk along, or climb a hill, or jump over a ditch and then walk on through the clouds. You'd admire the forests and fields from high above and try to find your home among them.

But unfortunately it isn't possible, although long ago people thought it was. They quite seriously believed that the sky was a large overturned bowl and the Earth was a huge saucer which had an edge just like any other saucer.

And, of course, they were terribly curious about what lay beyond the "edge of the world" and "on the other side of the



THE LITTLE HUMPBACED HORSE



sky". But no matter how far people travelled, they never managed to see the "edge of the world", even in the distance.

People decided that the saucer on which they were living was very large. Its edge was probably somewhere far beyond the high mountains, forests and seas, and it was very difficult to get there without the Little Humpbacked Horse.

However, people were still dying of curiosity. Every saucer lies on something, they reasoned. A saucer can't hang in the air. That's preposterous! So, the Earth must be resting on something.

But what was it supported by? There was no way of finding out.

And what's more, to confuse matters even more, there were sometimes earthquakes. The Earth shook, the mountains cracked and crumbled and gigantic waves swept over the shore. People felt like kittens on your blanket when you suddenly decide to turn over.

People thought that the Earth most likely rested on the backs of some kind of powerful and huge monsters. Everything was alright while they were asleep, but as soon as they woke up and started moving, an earthquake began. They decided that the Earth lay on three enormous whales, for there was nothing in the world bigger than whales. But if the Earth rested on whales, what did the whales rest on? The whales swam in the ocean, people told themselves. Whales always swim in the ocean.

But what does the ocean rest on?

The Earth.

And then the Earth rests on whales again?

Something was wrong. There was no end to it, like the tale about the chicken and the egg.

Then people began saying: "The Earth rests on three whales and that's that. And if that's not enough for you, go and look for yourself."

And no matter how ridiculous these stories seem to us nowadays, people then believed them. After all, no one knew

anything for sure and there was no one to ask.

In ancient times people could not travel great distances across the Earth. There were neither roads, cars nor ships, to say nothing of trains or planes. That was why no one managed to get to the "edge of the world" to see if the stories about the whales were true.

However, people did gradually begin travelling. They rode further and further on camels and crossed rivers and seas in large boats.

And so as not to get lost, travellers stopped looking down below and began looking upwards at the sky. How else could one find one's course on the sea where there was nothing but water, or in the desert where there was nothing but sand? But the Sun, Moon and stars could be seen from everywhere, including the sea and the desert. They could be seen from the forest and even the bottom of a precipice in the mountains. What's more, they were always in the right place. It was at this time that the expression "the guiding star" emerged.

The Sun, Moon and stars always moved around the sky in the same way. For example, the Sun never went backwards, from right to left; the Moon never rose and then stopped in the sky; the stars never skipped to other places. Day after day, year after year the Sun, Moon and stars moved round the sky at a smooth and steady pace like clock-hands.

No matter what happened on the Earth, whether there were thunderstorms, raging hurricanes or tempestuous storms at sea, the Sun, Moon and stars moved regularly round the sky, oblivious to everything else.

People decided that a very complex and intelligent machine must be hidden somewhere beyond the sky. This machine was probably like a clock mechanism and contained slowly revolving cog-wheels which were as big as mountains. These smoothly turned all the heavy sky and

stars above the Earth. The sky had to be really heavy. It was so vast!

If only one could get to the "edge of the world", pierce through the sky and see what was there! How fascinating it must be there!

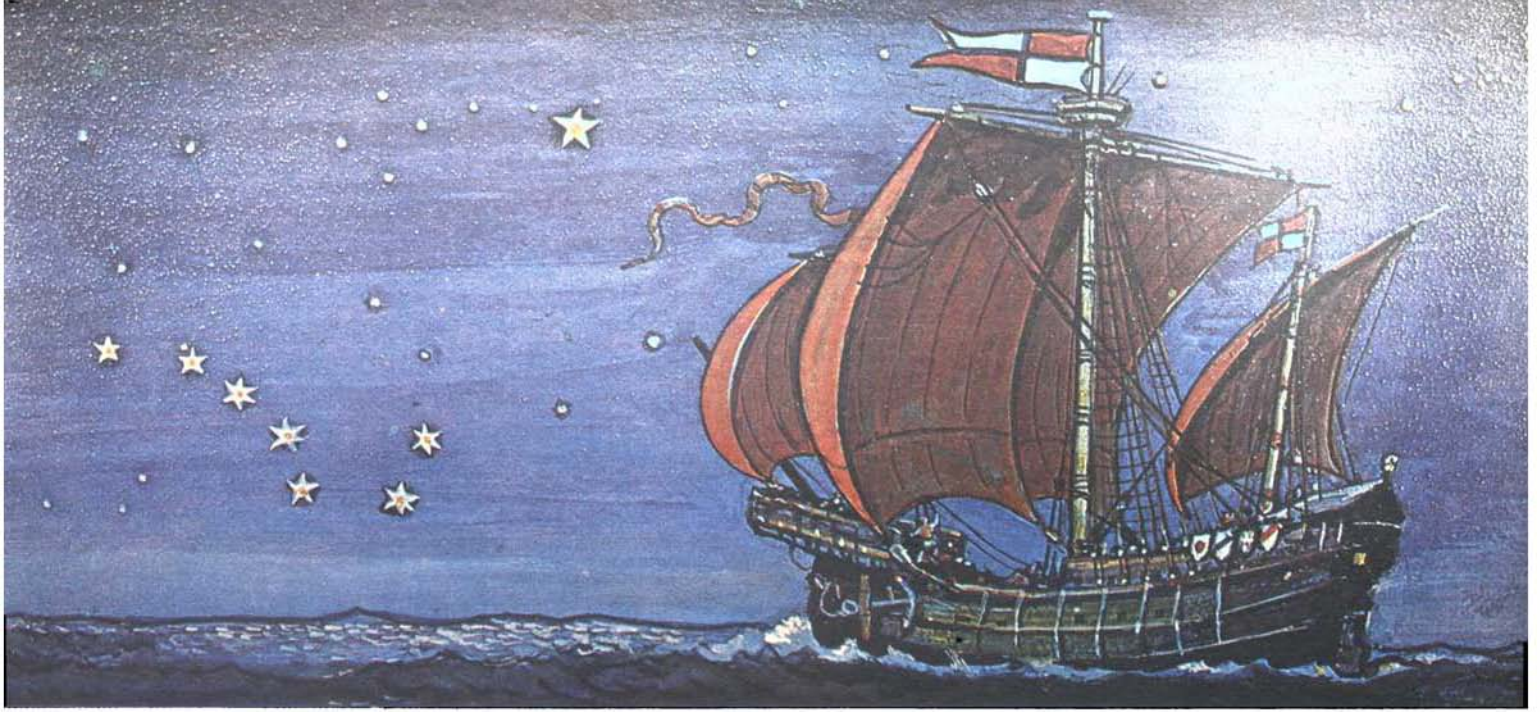
Don't laugh! People really believed in these "wheels" on the other side of the sky.

But all the same, everyone got used to the notion that there was always perfect harmony in the sky and they could totally rely on the "heavenly bodies" never to let them down. And this helped people make the most distant journeys.

For instance, as they moved towards the setting Sun day after day, travellers knew that they were going along in the same direction and, of course, were never wrong.

Don't forget that all this happened before there were compasses, maps or lighthouses. But as they travelled and looked at the stars, people noticed something strange. Sometimes they would set off on camels from their native village on a long journey and keep their eyes on a bright star.





They travelled for a day, two days and then a week and noticed that their star rose higher and higher above the horizon every night. It was as if they were moving not along a flat plain but across a gently sloping vast hill and could see further and further ahead. And when they were returning home the star, on the contrary, descended lower and lower as if they were going away from it down the hill.

So, people decided the Earth was curved like a huge round loaf.

Strangely enough, the water in the seas also appeared to be curved. This was noticed not only by seafarers but by people who lived on the coast. They looked from the shore at a ship putting out to sea and first saw all the ship, then only its sails and then only the tips of its masts. Finally, the ship disappeared completely out of sight, as if it had crossed a hill and went down the other side.

You can easily test this for yourselves on a sea- or lake-shore. The water only has to be calm and smooth. The lower

part of the ship begins to disappear under water at a distance of five kilometres, and completely vanishes at a distance of a few dozen kilometres.

This is why it's best to use binoculars.

It was difficult then for people to make themselves believe that the sea was curved, for they were used to thinking of water as something flat and smooth.

But it nevertheless became an accepted fact. People began to think of the Earth not as a flat saucer but as a hemisphere which, by some unknown means, was "covered" with seas.

However, the hemisphere also must have edges, but no matter how many people crossed the seas and travelled to the most far-off countries, no one ever managed to spot the ill-fated "edge of the world" even from a distance.

And there was one more puzzling thing: every day the Sun, Moon and stars descended somewhere, dived behind the edge of the world and slipped up on the other side the following day. What's more, they never got stuck against the

props which supported the Earth, the stars were always in the right places, and the Sun and Moon never rose late in the East.

It seemed as if the space under the Earth through which the heavenly bodies passed was absolutely empty.

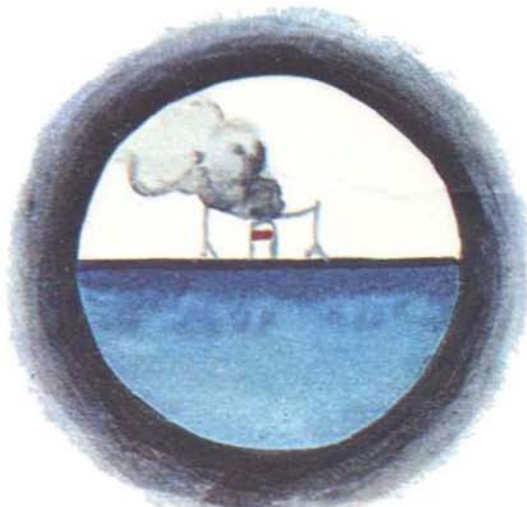
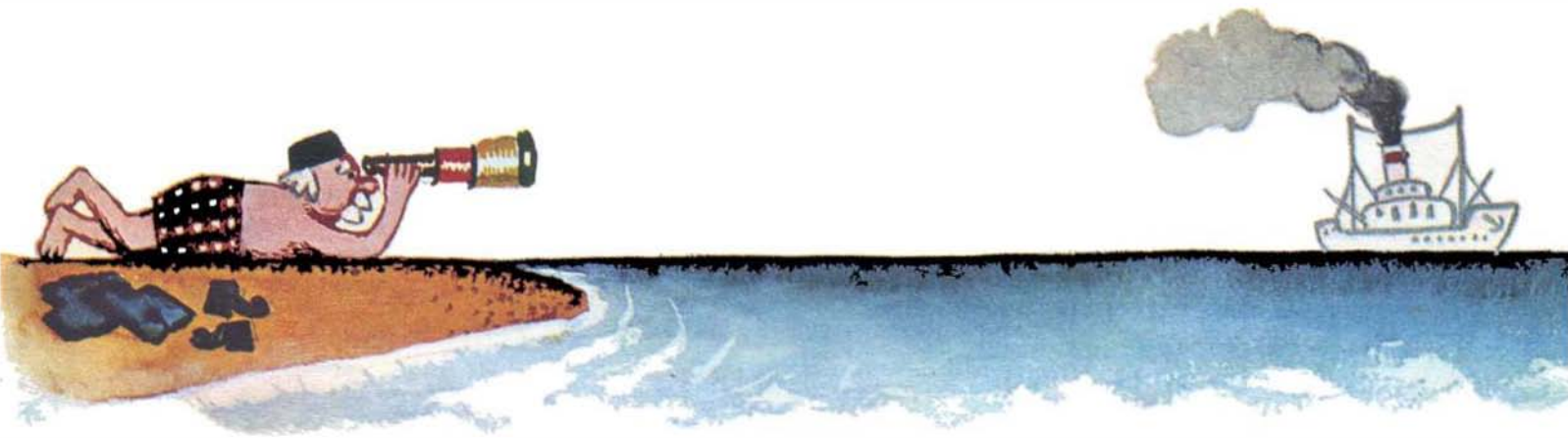
And people came to the conclusion that there weren't any supports at all, the Earth was not a hemisphere but a sphere, and that this sphere was not supported by anything but suspended by some miraculous means.

And if this was so, it was easy to solve the puzzle why the Earth had no edge and why the Sun passed so easily under the Earth at night.

Nobody could still understand how the people on the other side of the Earth held on, for they must be hanging upside down!

Hundreds of years passed before people learnt to build large ships on which they could sail safely across the oceans. People travelled round the world on them, and became finally convinced that the Earth was a sphere, and realised that no one on the Earth was hanging upside down. The Earth, you see, was always below them.

Nowadays all children know that the Earth is a sphere. There is a globe in every school and in almost every home. But how hard it was for people to guess this at first!





Why Are Stars So Beautiful?

On a fine evening as it is getting dark, let's go into an open field or onto a sea-shore where the view of the sky is not obstructed by houses or trees, and where there are no street-lamps or window-lights.

Look at the sky! How many stars there are! They look like tiny little holes made by a sharp needle in a dark dome against a fiery blue sky.

And how different they are! They are big and small, blue and yellowish, some all alone, others in little clusters.

These clusters are called "constellations".

Thousands of years ago men looked at the starry night sky just as we are looking at it today.

The sky then served as a compass, clock or calendar. Travellers used the stars to find their way. By the stars people

knew when it was morning and when the spring would arrive.

The sky has always been useful in every sphere of life. Lost in awe and wonder, people gazed at it endlessly.

What are stars? How did they appear in the sky? Why are they scattered across the sky the way they are? What are constellations?

It is quiet at night: the wind dies down, the leaves no longer rustle and the sea grows calm. Birds, animals and people sleep at this time. And as you look at the stars in this silence, all sorts of wondrous tales drift into your mind.

People of the distant past have left us many tales about the stars.

You see those seven bright stars over there? We've drawn a picture of them. It looks as if a dipper has been drawn in dots in the sky.

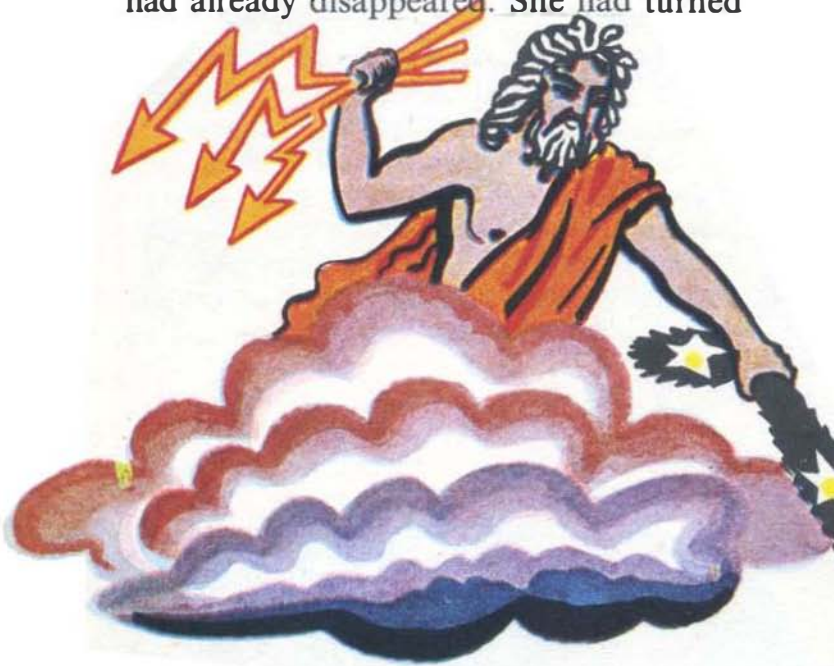
In Ancient China this constellation was called Pieh Tiewu which means "pot" or "dipper". In Central Asia where there were many horses these stars were named "The Tethered Horse" and in our part of the world they were called "The Great Bear".



Of course, a bear and a dipper do not look very much alike, but this is only because a bear has a short tail.

Anything can happen in a story. This one was composed by the Ancient Greeks.

Once upon a time King Laocoön ruled the country of Arcadia. He had a daughter by the name of Callisto. She was fairer than all the maidens in the world. Even the beauty of the fairest goddess, Hera, waned beside her. And the goddess Hera became angry with her rival. As a sorceress, Hera could do anything she wanted. She decided to turn beautiful Callisto into a hideous bear. Hera's husband, the omnipotent god, Zeus, wanted to intercede for the defenceless maiden, but was too late. He saw that Callisto had already disappeared. She had turned



into a hideous, shaggy beast which went about with its head bent.

Zeus felt sorry for the beautiful maiden. He took the bear by its tail and dragged it into the sky.

He dragged it with all his might for a long time and gradually the bear's tail became stretched.

When he had dragged it into the sky, Zeus turned the deformed long-tailed



bear into a bright constellation. Since then people have admired it every night and recalled beautiful young Callisto.

The Pole Star shines in the sky near the Bear. It's easy to find. Imagine a line drawn in the sky through the two extreme stars of the Bear as we've drawn it. And then mark off five "points" on the line at the same distance as between the stars of the Bear, and you'll come across the Pole Star. It's not very bright but has to be remembered: it shows the way to the North.

On the other side of the sky there is a cluster of tiny stars called the Pleiades. There are six of them and they are huddled together like frightened, helpless little ducklings on a pond.

A very long time ago story-tellers composed the following tale about the Pleiades, the Pole Star and the Bear.

Once upon a time there lived seven robber brothers. They heard that seven maidens, seven beautiful, modest and





loving sisters lived far, far away at the end of the Earth. The brothers decided to take them for their wives. They mounted their horses, galloped to the end of the Earth, and lay in ambush. And when the sisters went out for a walk in the evening, they fell upon them. They managed to seize one but the others ran away.

The robbers carried off the maiden but were severely punished for this. The gods turned them into the stars we call the Great Bear and made them guard the Pole Star.

If the night is dark and the sky is clear, you can see a tiny star very close to the middle star of the Bear's "tail". This is the abducted maiden.

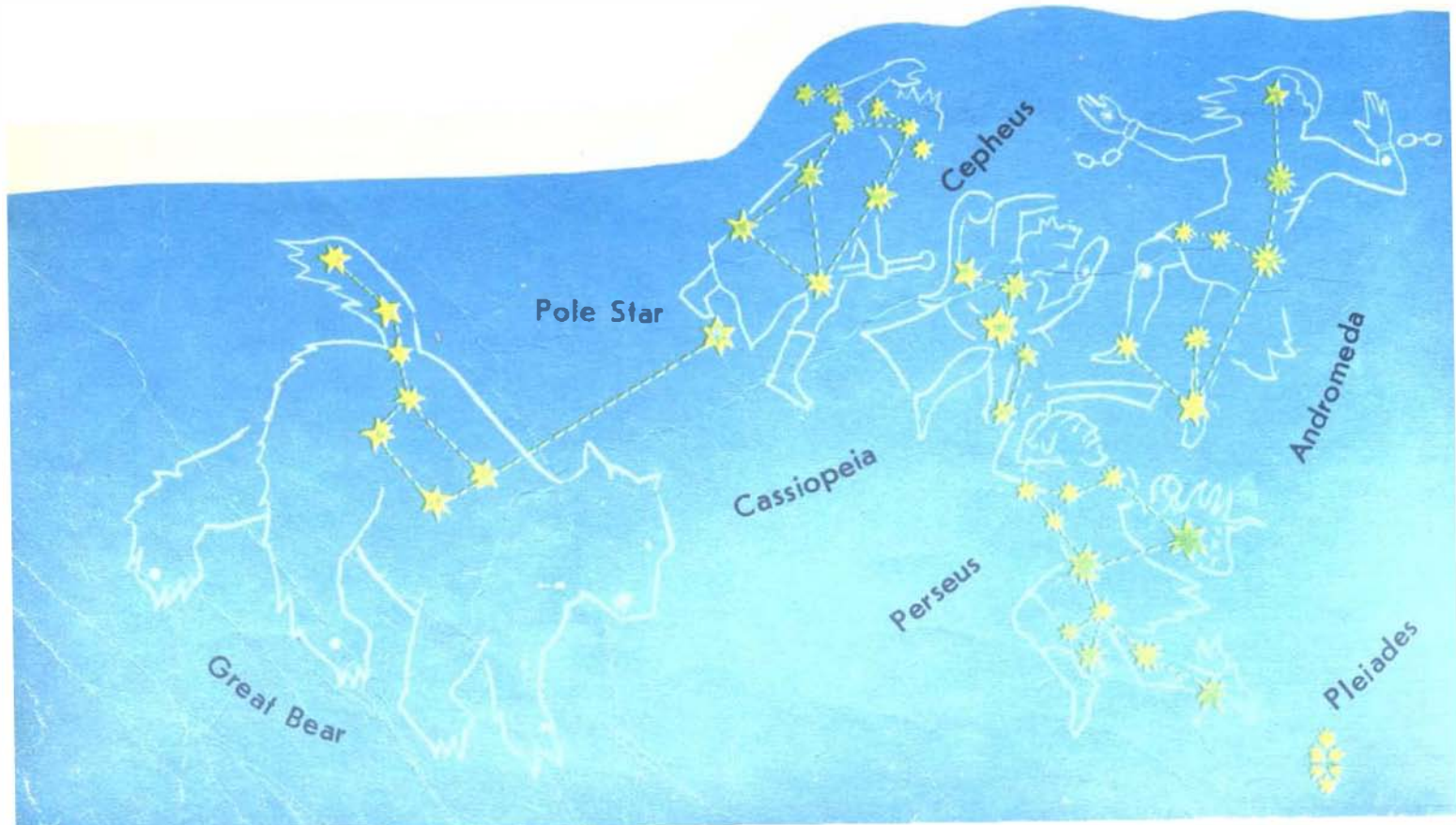
And the Pleiades consist of the other six maidens. They huddle together in fear and go timidly up into the sky in search of their sister every night.

On the other side of the sky several little stars are scattered in a semicircle ablaze with light. This constellation is the Northern Crown.

The Ancient Greeks used to tell of a beautiful maiden called Ariadne who was the daughter of the King of Crete. She loved a valiant warrior by the name of Theseus and went away with him without fearing her father's wrath. But on the journey Theseus had a dream in which the gods ordered him to leave Ariadne. Theseus did not dare to disobey the gods' order. He sadly left Ariadne crying on the sea-shore and went on alone.

The god Bacchus, who heard Ariadne crying, took her for his wife and made her a goddess. To immortalise Ariadne's beauty, he took the crown of flowers from her head and threw it into the sky.

As the crown flew through the air, the flowers turned into jewels and when they reached the sky they became bright stars.



And looking at this crown of stars, people remember the fair Ariadne.

Then there is another constellation. Look at our drawing. There are five stars like the letter "M" with spaced-out legs. They reminded people of antiquity of a maiden half-reclining in a chair. This constellation is Cassiopeia and is surrounded by three other constellations: Cepheus, Andromeda and Perseus.

The Ancient Greeks composed a story about these stars.

Long, long ago King Cepheus ruled the country of Ethiopia. He had a beautiful wife by the name of Cassiopeia, but she began to flaunt her beauty before the sea sorceresses, the Nereids. They were offended and complained to Poseidon, the King of the Sea. In a rage Poseidon sent a terrible giant whale to the shores of Ethiopia.

How was the whale to be humoured so that it would leave the poor country in peace?

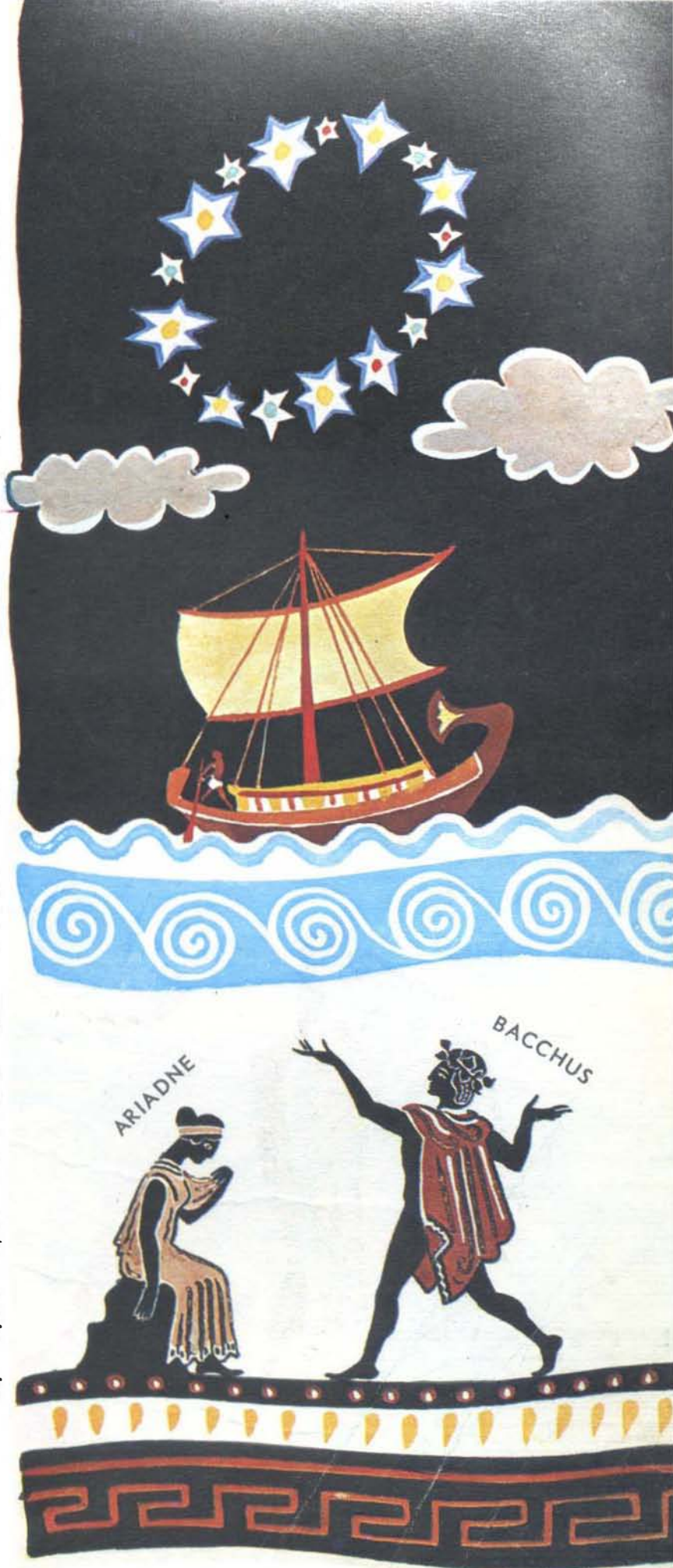
Wise men advised Cepheus to give the fairest maiden in the land, his darling daughter Andromeda, to the whale.

The king was beside himself with grief. But what could he do? He had to save his country from the terrible whale at all costs. He decided to sacrifice his daughter.

Andromeda was taken to the shore, chained to a cliff and left alone. The whale would swim up and take her.

At this time far away from Ethiopia the brave warrior Perseus was preparing to accomplish an amazing feat. He had made his way to the lonely island inhabited by the Gorgons, terrible monsters in the form of hideous women. Snakes swarmed on their heads instead of hair and anyone who caught sight of them froze with fear and turned to stone. Perseus crept up to them while they were asleep and beheaded Medusa, the chief Gorgon.

After hiding the terrible chopped-off





head in a bag, he sped home through the air on magic winged sandals.

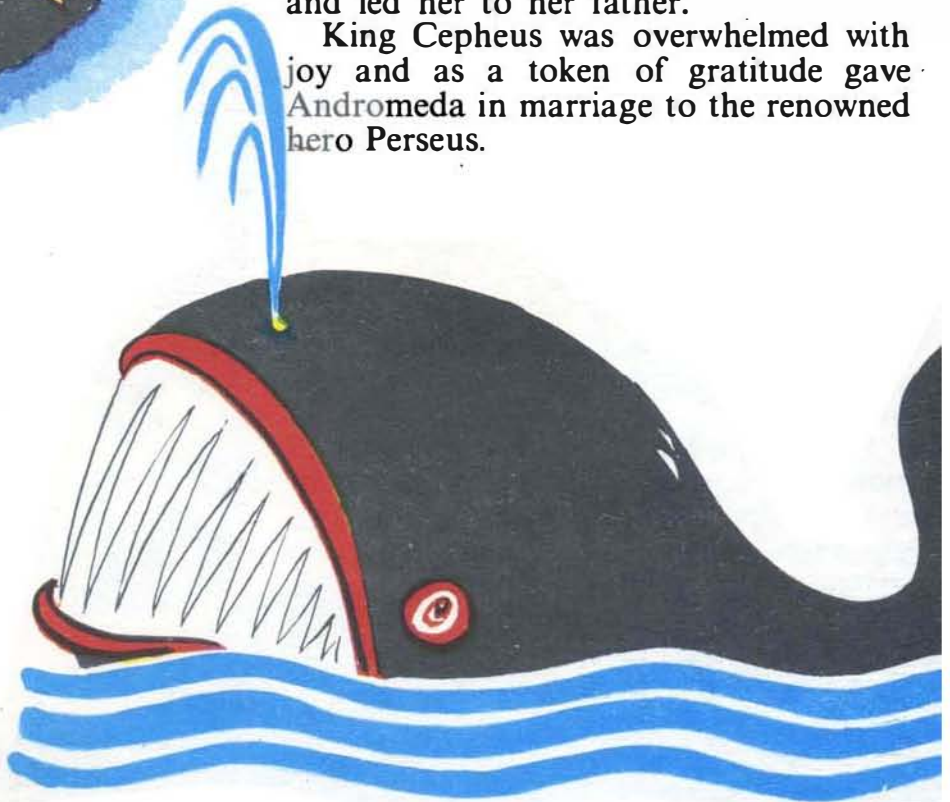
As he flew over Ethiopia, Perseus spotted beautiful, sobbing Andromeda chained to a cliff by the sea.

But at this moment the terrible whale was swimming towards the cliff and was about to seize Andromeda.

Perseus pounced upon the whale, struggled with it for a long time and then showed it Medusa's terrible head. The omnipotent monster turned to stone in horror.

The whale became an island off Ethiopia. Perseus freed the fair Andromeda and led her to her father.

King Cepheus was overwhelmed with joy and as a token of gratitude gave Andromeda in marriage to the renowned hero Perseus.



There are many constellations in the sky and many tales have been composed about them. The stars clustered in the shape of a cross are known as the Swan constellation. This is supposedly the all-powerful god Zeus who turned himself into a white bird and is flying to people on the Earth.

And over there is the remarkably beautiful Orion constellation. Orion is the

legendary intrepid hunter who brandished a cudgel at a huge beast.

The Scorpio constellation shimmers on the other side of the sky. When you look at these stars, they seem like the limbs of a cunning insect shining in the darkness.

The starry sky is a book of innumerable tales.

But that's enough of tales. We still need to know what stars really are.

Scorpius



Swan



The only trouble was that people then did not know how to fly and therefore for a very long time could not find out how high this ceiling was and what it was like. Was it thick and solid like stone or thin, and fragile like glass? And why was it blue by day and black by night?

People have thought long and hard about this. Some thought that they were tiny holes in the ceiling through which light filtered. Others thought that the stars were the heads of gold and silver nails hammered into the sky. However, they all agreed that the sky was a hard dome-shaped ceiling. That explained why the stars never moved out of place. Day after day, year after year, none of the clusters of stars or constellations changed in the slightest. It seemed as if they were firmly fixed or "nailed" to something.

After all, if the stars "floated" in the air like motes, they could never keep in position and the constellations would change shape. But as the constellations were firmly "nailed", the sky was obviously solid. And if it was solid, then you could fly up and touch it with your hand.

Orion





Can the Sky Be Pierced?

Let's try to "pierce" through the blue sky. Let's get into a rocket and fly upwards.

The rocket begins to drone louder and louder, roars deafeningly, shudders and moves smoothly upwards.

The Earth outside begins to vanish downwards.

The needle of the altimeter on the panel shows 1 kilometre, 1.5 kilometres, 2 kilometres...

It looks as if we're going to hit the clouds. We even feel afraid for a moment. But, of course, we don't hit them. The clouds are soft like smoke.

We're now at an altitude of 3 kilometres.

The clouds cluster round us. How beautiful they are! They're like huge mountains of whipped cream or enormous wads of cotton wool.

Between the clouds you can see houses and trees on the ground. From this great height they look like toys.

We continue to go higher. We're now at an altitude of 10 kilometres. We've left the clouds far below. They now look like snow-drifts seen from the top floor of a house. You can still see the ground

between the clouds, but only vaguely like in a mist. The houses and trees merge together and you can only see grey dots: forests, fields, lakes and towns.

The sky above is now very clear and no longer azure but deep blue.

We'll soon reach the "ceiling". It's probably time for the rocket to slow down or else we'll hit it too hard.

But the rocket is flying faster and faster. It is even getting frightening.

Let's look out the porthole. The "ceiling" must be very close now?

Look, what's happening? The deep blue sky isn't getting any closer but it's dissolving strangely. It's changing from dark blue to dark purple and becoming darker all the time. We're 40 kilometres high!

The sky has become almost pitch-black like at night.

You can even see the stars. It's the middle of the day. The Sun is shining brightly but there are stars next to it.

What's happened? Where's the blue sky gone?

It's not above us, nor is it to the right or the left. Perhaps it's below? Let's look down. The Earth's still there. The

clouds are lying on it like small balls of cotton-wool on a floor. But the Earth and the clouds are shrouded by a dense azure mist.

So that's where the blue sky has gone to. It's below us! As we were moving upwards, we imperceptibly "pierced" through it, as if we were passing through a roof full of holes and we are now "above the blue sky"!

It appears that the blue sky above the Earth is like a layer of morning mist above a swamp. And the blue sky is not so dense: it was only about 30 kilometres thick. And it's not at all difficult to pierce, but no hole is left behind. But how can a hole be left in smoke or mist?

It appears that there are two completely different skies. The one nearer to us is azure and the other further away "behind it" is black. But we thought that one and the same "ceiling" changed colour day and night.

It appears that the black "ceiling" is black in the daytime, too. What's more, it is always in the same place, day and night. And the stars always shine in it, but during the day it is screened from us by a blue mist.

But what happens to the blue sky at night? Nothing. It simply becomes transparent and invisible at night.

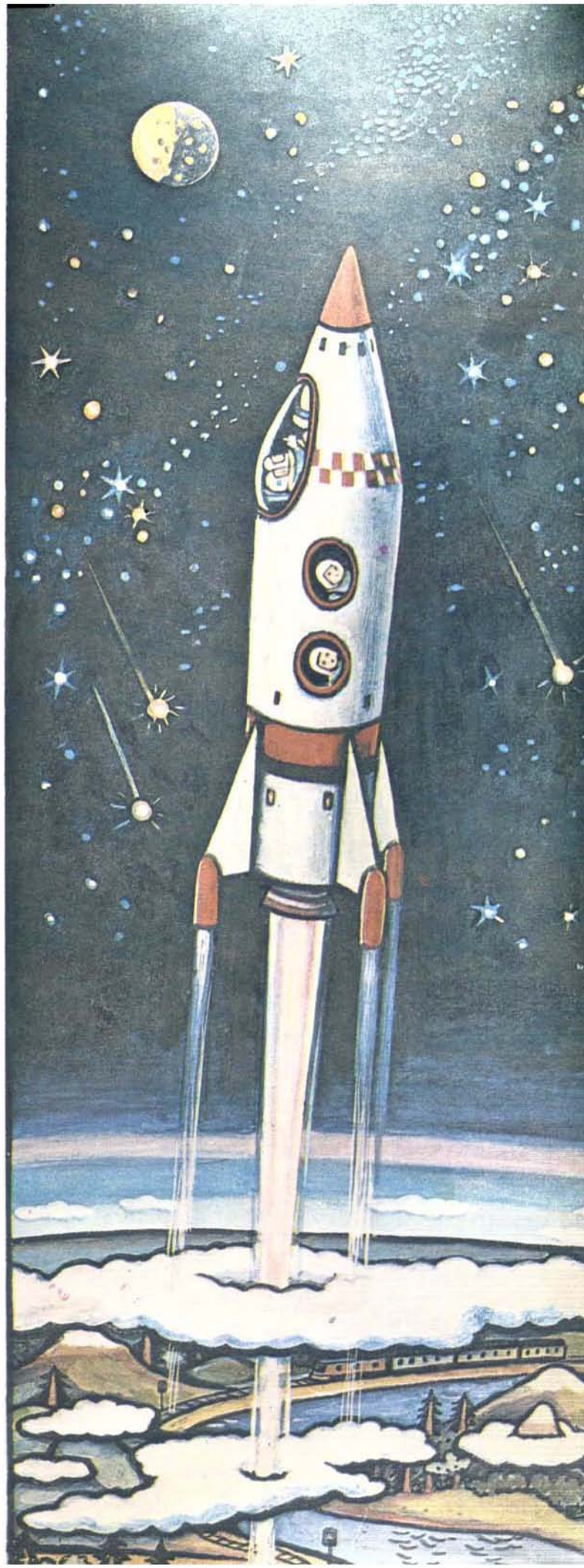
The blue sky is air. It is the same air we breathe and birds and planes rest their wings upon.

The air is transparent, but not completely. It always contains a lot of dust. When it is dark, the dust is not visible. At night we cannot see it and we think there's no air above us. But during the day the air is lit up by the Sun and every mote floating in the air begins to shine like a tiny spark. The air becomes turbid.

Remember how dusty the air seems in a dark room penetrated by a sunbeam.

But what is the black starry sky which is now above us? Is it far away?

We continue to fly away from the Earth. We have been flying for a long time.



Air



We are now at an altitude of 10,000 kilometres. The stars have not come any closer but there's a good view of the Earth from here. You can now see that the globe is completely wrapped in blue film-like fabric.

We already know that this is turbid air, but for those inside this film on the Earth itself, it is blue sky. They are now under this "roof" and cannot see the stars, but we can.

The film of air outside gradually disappears but there is still air even at a distance of 3,000 kilometres from the Earth. True, it is now very thin.

But what about further away?

Further away there is no air at all. There is empty space.

What is empty space? How does it differ from the air?

In fact, it differs very much.

We can breathe in the air, but in empty space we can't. In empty space we will have to put on a special air-tight rubber suit known as a spacesuit, and pump air into it from cylinders strapped on our backs.

The air can be warm and cold. That's why we sometimes feel warm and sometimes cold in the air. In empty space it's always cold. You have to wrap up warmer there. In empty space you feel as if you're in front of a fire in the freezing cold: the

sun warms you on one side and the black starry sky chills you on the other.

If you throw a bird's feather into the air in windless weather, it won't fly but will flutter down nearby. The air prevents it from flying, but there is nothing to do so in empty space. There our feather can fly very far, just like a heavy metal object.

Birds fly in the air. If there was no air, they would have to walk on the ground for their wings would be of no use and they would have nothing to lean on. Planes cannot fly in empty space, either.

But empty space around the globe which is "coated" with air is called cosmic space, or space for short.

And it appears that no matter how long we were to fly in this empty space in any direction, whether for a month, year or a thousand years, we would never reach the end of it or the "black ceiling".

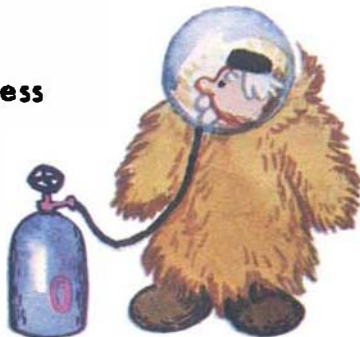
The Earth in space is like an island adrift in an immense ocean.

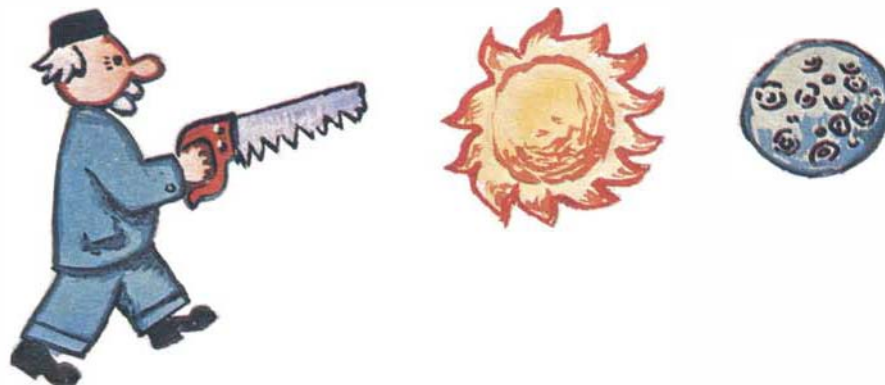
There are other "islands" in space which can be seen from the Earth: the Moon, the Sun, and the stars. You can fly to them but black, empty space lies beyond them, too.

Empty space is infinite and there is no "black ceiling" either of stone or crystal.

And so, only the blue sky can be "pierced". This is not at all difficult. The blue sky is quite near to us and is "soft" like smoke or mist.

Emptiness





What Are the Sun and Moon Made of?

People began flying in space quite recently. Yuri Gagarin was the first to fly there in 1961 and since then several dozen Soviet and American astronauts have followed him.

However, something had to be known about space before man was sent on such a dangerous journey.

How did people on the Earth find out about the black night sky, the Moon, the Sun and the stars? Even if you look at the sky all night long, it still seems like a ceiling, the Sun and the Moon like flat shining discs and the stars simply like bright dots.

How can you examine them more closely?

You can examine an ink dot on a piece of paper through a magnifying glass. Have you ever tried? If you just look at it, it's an ordinary dot, but if you look through a magnifying glass, it becomes big and fibrous and the paper is no longer smooth but like rough woolly material.

If you look at your finger through a magnifying glass, it seems huge and fat and every crease is visible.

But the dot on the piece of paper and one's finger are close-by and you can use a magnifying glass to take a closer look

at them. But you can't use it to study the sky, can you?

However, there are also magnifying glasses for the sky.

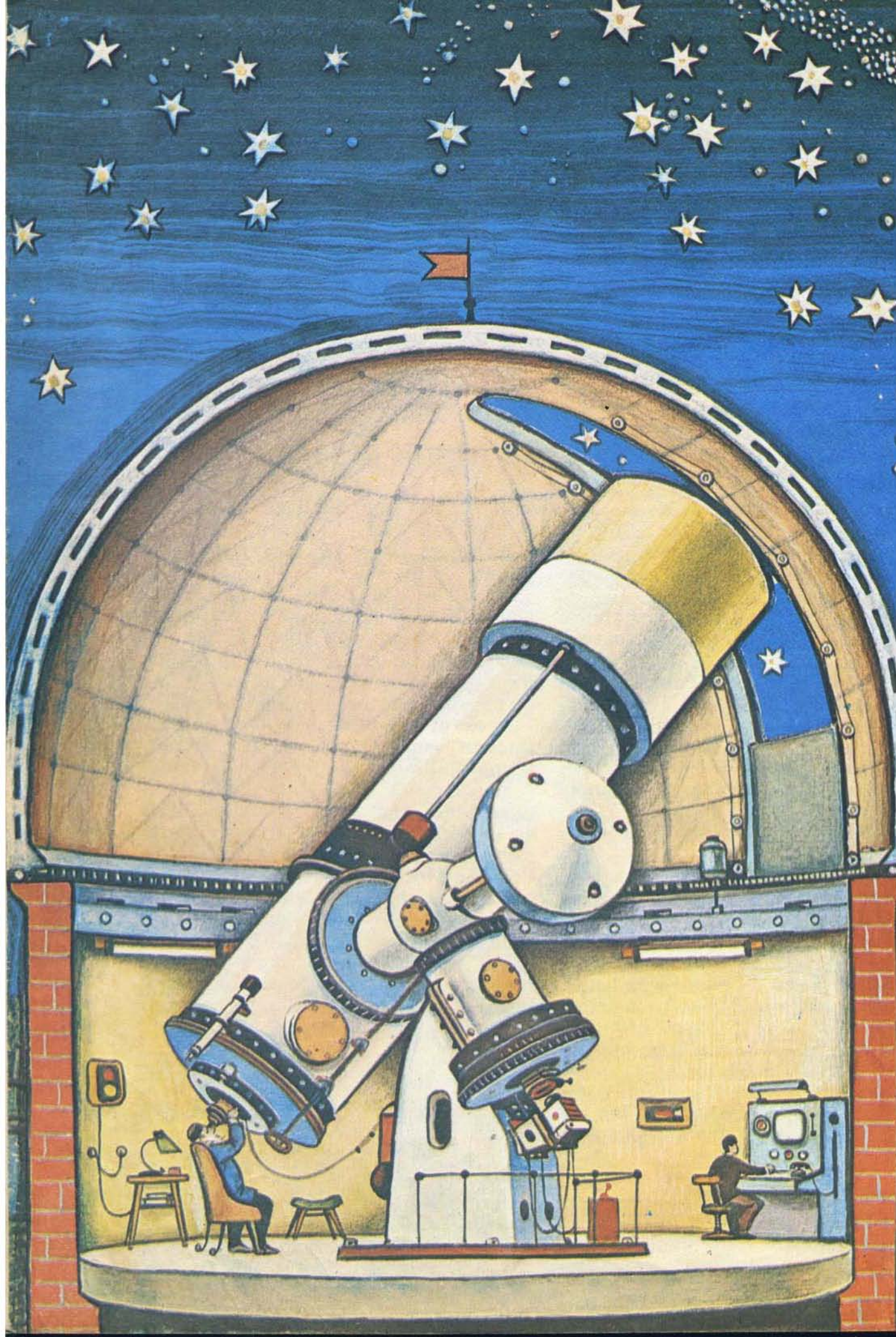
Have you ever looked through binoculars? You probably have. Binoculars are also "magnifying glasses", but you don't have to put them right against the object. You can look at everything in the distance through binoculars.

Look at the other side of the street through some binoculars. It's become nearer and larger, hasn't it?

Small opera glasses magnify things three times and large binoculars, such as the ones sailors use, magnify things eight times. Through binoculars of this kind the Moon seems huge, just as if we had flown eight times closer to it. We can even make out many different small spots on it which we couldn't see before.

But what happens if you make some very large binoculars, the size of a cupboard? They'll most likely bring the Moon even closer, right up to your nose? That's right.





However, you don't even have need to make a pair of binoculars, one for the right eye and one for the left. You can look at the sky with one eye.

And so people made "half" a pair of binoculars which was the size not of a cupboard but of a bus.

This huge tube with lenses was called a telescope.

It is so huge that not even two dozen men can lift it up. The telescope, therefore, had to be put on an enormous firm stand. It is not turned by hand but by electric motors and many cog-wheels.

A stone house or rather a large round tower is built for every telescope.

The roof of this tower is moveable. When you want to look at the sky, the roof is moved aside, and when you finish work and leave, the roof is shut so that the rain does not fall on the telescope.

A telescope is a complicated and expensive instrument.

But how wonderfully it magnifies everything! Hundreds, even thousands of times! Through this kind of telescope you can read a book a mile away! The book only seems a foot away!

With the help of these wonderful tubes known as telescopes, people have looked all over the sky and closely examined the Sun, Moon and stars.

People have discovered many interesting facts about what is around the Earth, and telescopes have helped them in their work.

It appears that the Sun is a huge sphere. The same is true of the Moon and the stars. The latter look like small dots only because they are very far away. A large street lamp also looks like a small dot when it is many miles away.

All the spheres in space are called heavenly bodies. They all are very different.

The Sun, for instance, consists mainly of fire and contains nothing solid inside. If there was a giant as big as the Sun, he could easily pierce it with a stick like a

bonfire. This wouldn't harm the Sun but the stick would at once catch fire and burn.

The stars are very like our Sun. They are also made of fire. Like the Sun, stars are huge balls of fire. Many of them are even bigger than the Sun. The Sun is simply nearer to us. That's why it seems big and why it is bright and hot. But the stars are much further away from us than the Sun. That's why their light is weak and they emanate no warmth.

The Moon is also a sphere, but it is solid, cold and made of rock like the Earth. The Moon does not shine. Cold rocks cannot emit light. The Moon is visible in the sky only because it is illuminated by the Sun. If the Sun were extinguished, the Moon would be, too.

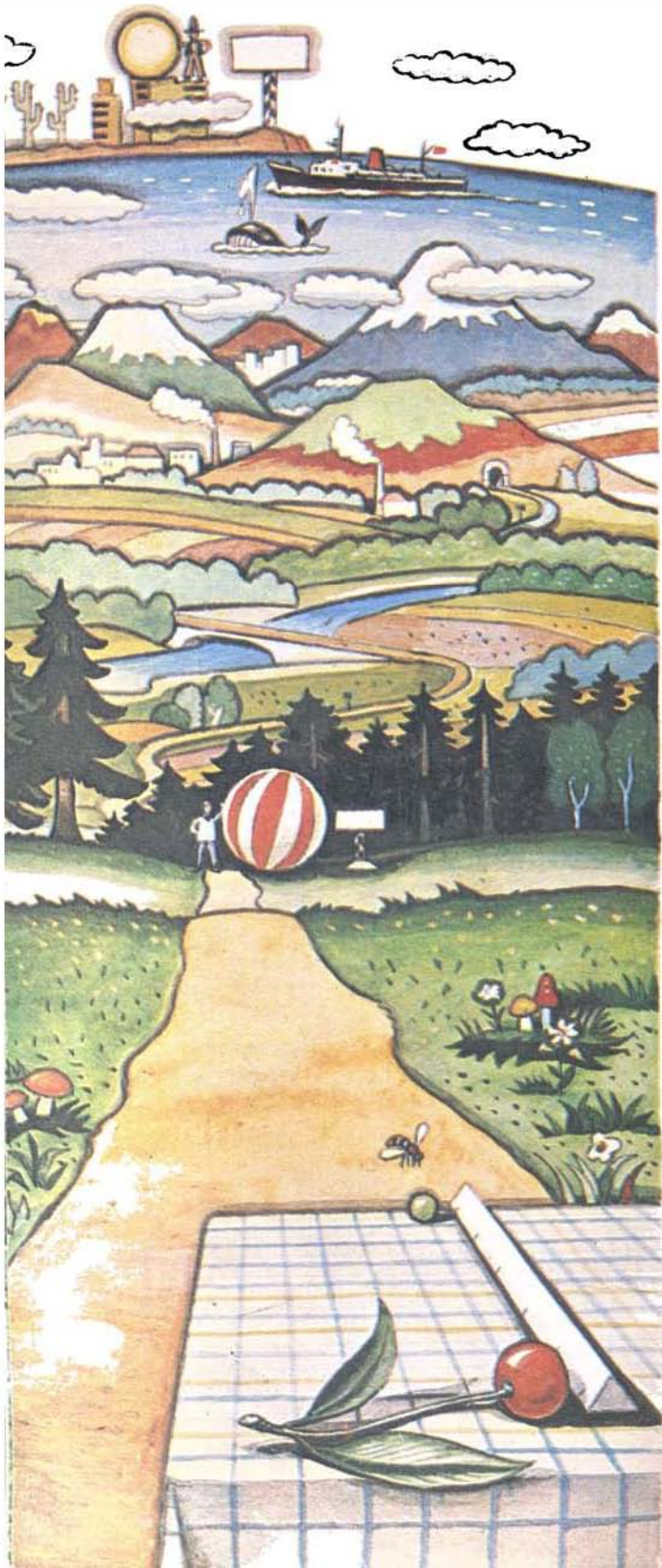
If we drew the Moon, the Earth and the Sun next to each other on a piece of paper, the Moon and the Earth would fit on, but the Sun wouldn't. It would have to be drawn the same size as a cupboard, because this is how enormous it is compared to the Earth and the Moon.

The heavenly bodies in space are very far away from each other. If we imagine that our huge globe is the size of a cherry, then the Moon is the size of a pea at a distance of half a metre, and the Sun is the size of a cupboard at a distance of 200 metres! And the nearest star, like the Sun, is the size of a cupboard thousands of kilometres away, in America or Australia.

That's how far the heavenly bodies are from each other.

The Moon is the nearest to us, but even the latest TU-154 jet would take two whole weeks to get there.





Imagine Leningrad, for instance. It takes five whole hours to walk across this large city. A car can speed across it in thirty minutes and the latest jet flies across it in one and a half minutes. That's how fast it flies!

But it takes two weeks to fly to the Moon at this speed! In one and a half minutes we've passed the whole city, in an hour we've crossed forty Leningrads and in twenty four hours a thousand Leningrads! But imagine travelling at this tremendous pace for two weeks!

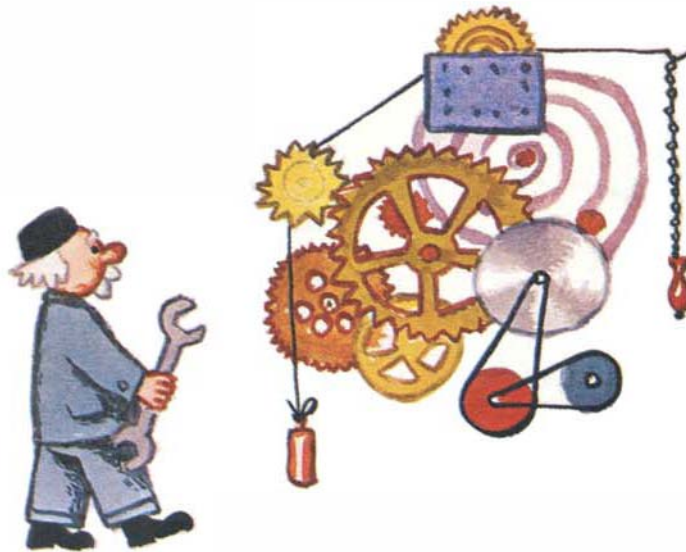
The Moon's a long way away! But it's still much nearer than all the other heavenly bodies. That's why it's called the Earth's satellite. All the other heavenly bodies, as you can see, are much further away. It would take 15 years to fly in a plane to the Sun! Schoolchildren would get into the plane at the start of their flight and grown-ups with beards would then emerge when they returned.

You could never fly to the stars at this speed. You'd only have flown a little of the way before you were old.

How vast space is!

And yet all of it is emptiness!

How is the Sun suspended in this emptiness? Why doesn't the Moon collapse? What is the Earth supported by?



What Is Everything in Space Supported by?

If you lift a ball and then open your hands, the ball immediately drops onto the ground. It can't stay in the air, can it? It has to be supported by something. It either lies on the floor, floats on water or hangs on a string.

Everything on Earth is supported by something, and if it isn't, it drops downwards.

You disagree? This isn't necessarily true of a balloon or a light bit of fluff? You're right. They may even fly upwards, but this is only because the balloon and bit of fluff are supported by the air. They are so light that they float in air, just as a piece of wood floats in water in a bowl. Try pouring the water out of the bowl. The piece of wood will immediately sink to the bottom. It's the same with air. If all the air was taken away from the Earth, all the objects floating in the air would sink to "the bottom of the ethereal ocean", commonly known as the Earth. This, of course, includes balloons and bits of fluff. Birds and planes would not be able to fly, for they are also supported by the air.

Everything in the world would drop downwards if it wasn't supported by anything.

But there's no support in space. It is empty. The globe cannot lie or float in it.

How can our vast and heavy Earth, Moon, Sun and stars survive in empty space with no support?

Why doesn't the globe drop?

Drop? Who says it doesn't?

That's the whole point! The Earth with us on it is constantly dropping and flying downwards into a bottomless precipice.

But how can this be so? It's dreadful to be on a sphere which is dropping somewhere. When you fall, you always land somewhere in the end.

Where is the Earth dropping to? Where will it land?

Where does everything drop to?



Where? Downwards! But where downwards?

What a strange question! Downwards, somewhere below.

Well, let's draw the entire Earth. Is the Earth a sphere? Yes. Do people live all over this sphere? Yes.

So we've drawn four boys on each side of this sphere. All the balls will drop onto the Earth and all of them will say that the balls dropped downwards.

But only one of the balls, which dropped downwards, really did so in our drawing. The second ball dropped to the right, the third to the left and the fourth even dropped upwards.

But if you turn the page round, the fourth one dropped downwards and the first upwards.

So, "downwards" can mean anywhere: downwards, sideways and upwards. "Downwards" means towards the Earth.

Everything on Earth drops onto the Earth and flies towards the globe from every direction.

The globe attracts everything around it like a magnet attracts iron nails. In fact, this doesn't only apply to the globe. All objects attract each other, but they're too weak to have any effect. A cupboard attracts a sofa but it does so too weakly to ever move it from its place. It couldn't even move a ball.

A house attracts a cupboard but can't move it. A mountain attracts a house, but even it can't shift a house.

But the globe is much bigger than everything else and it attracts everything so strongly that this is at once noticeable. The globe attracts a cupboard so strongly and holds it so firmly that it's impossible to move it. You think that's because it's heavy? Heavy really means "strongly attracted to the Earth".

If the globe suddenly stopped attracting everything on it, our cupboard would rise from the floor and float around the room like specks of food in an aquarium.

It would no longer be heavy, but light like a balloon.

And so, all objects attract each other, but the stronger, larger object wins and the smaller, weaker object flies towards the larger, stronger one and falls onto it.

Small things, thus, always fall on big ones.

Now let's return to our question: where is the Earth falling in space?

Towards the Moon? No, the Moon is smaller than the Earth. Towards the stars? They're too far away. Towards the Sun? Of course, towards the Sun!

Small things always fall onto big things. Our huge Earth is quite small compared to the Sun.

So, the Earth is falling towards the Sun.

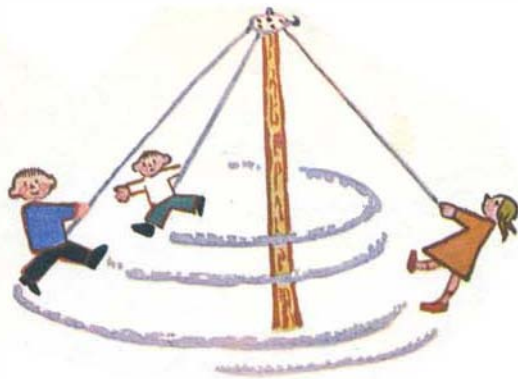
But that's dreadful! The Sun is a ball of fire. That means, the Earth will soon crash into the Sun and be consumed in a sea of fire, doesn't it? We'll burn like in an oven?

Don't worry, you can fall without hitting anything. You can fall past!

At some time or other you've probably played on a rope attached to a post? What happens if you step back from the post, make a run and push off with your feet? You fly past the post. When you spin round, you keep feeling that the post is attracting you. That's why you don't fly in a straight line but keep turning and falling towards the post. But you're flying fast, so you don't turn sharply, but gently. That's why, you never fall against the post, but fly past as you spin round and round.

Something like this happens in space. The Sun is the post and the Earth is you.

If the Earth stood still, it would begin falling straight towards the Sun. But that's the whole point: the Earth doesn't stand still. It flies sideways, as if gathering speed to fly past the Sun into the distance. The Earth is attracted by the Sun and turns towards it. But it turns slowly and gently because it is flying very fast. That's why it does not draw nearer to the Sun



but only flies round it, just like you when you're spinning round a post on a rope. But you often have to push off the ground with your feet so as not to stop. This is because the ring at the top of the post grates and turns badly, and the wind blows in your face and stops you. But there is nothing in space to stop the Earth: no head-wind, no rope on a ring and no bumpy ground. In fact, there's nothing at all there. The Earth used to fly sideways, but then it stopped, and for several billion years it has circled round the Sun and cannot stop.

The Moon moves in space in a similar way, except it moves around the Earth and not the Sun. The Earth is much bigger than the Moon. So, the Moon falls towards the large Earth, but also flies past it and never falls onto it. As the Moon also flies fast sideways, it also cannot turn sharply.

It appears that none of the heavenly bodies are suspended on anything in space and they all are constantly falling somewhere. That is why they spin round and round.

The Moon revolves round the Earth which revolves round the Sun.

But like the Earth and the Moon, the Sun also does not stand still. It is falling somewhere into an abyss between the stars which are floating in space.

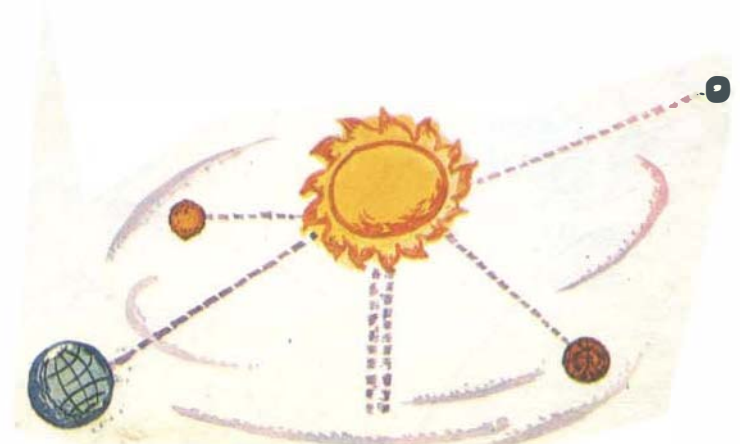
None of the heavenly bodies stands still in space. They all are flying somewhere. It's lucky there's plenty of space!

But strangely enough, when you look at the sky, you don't notice that the heavenly bodies are flying. The Moon, for instance, looks as if it's stuck to the sky. That's because the Moon is a long way from us.

Have you ever noticed that how slowly a distant ship on the horizon seems to be crawling along? In fact, it's racing over the waves and you couldn't catch up with it. And how slowly the speck of a distant plane moves across the sky!

The Moon flies four times faster than a jet in the sky. Imagine how it would roar past us if we were standing next to it! But from distance it seems to be only crawling. And you can only judge this by the stars next to it.

The stars are many times further from us than the Moon. That's why they seem to be standing still, although in fact they are flying





Why Does the Sun Rise and Set?

Do you think that we could live without the Sun? Of course not. The Sun illuminates and warms the Earth. Without the Sun's warmth plants' seeds can't grow, leaves on trees can't blossom and the crops in fields can't ripen. The Sun's rays bring joy to birds, animals, insects and, of course, people.

Without the Sun it's cold, dark and unpleasant. At night all living creatures try to hide, fall asleep and wait until the cold and darkness are over. And when the Sun rises, all of nature awakens and comes alive.

The Sun is the source of life on Earth. It is needed by everyone and that's why since time immemorial people have worshipped the Sun, thanked it for its warmth and hailed the sunrise in the mornings.

Look what beautiful stories the Ancient Greeks composed about the Sun.

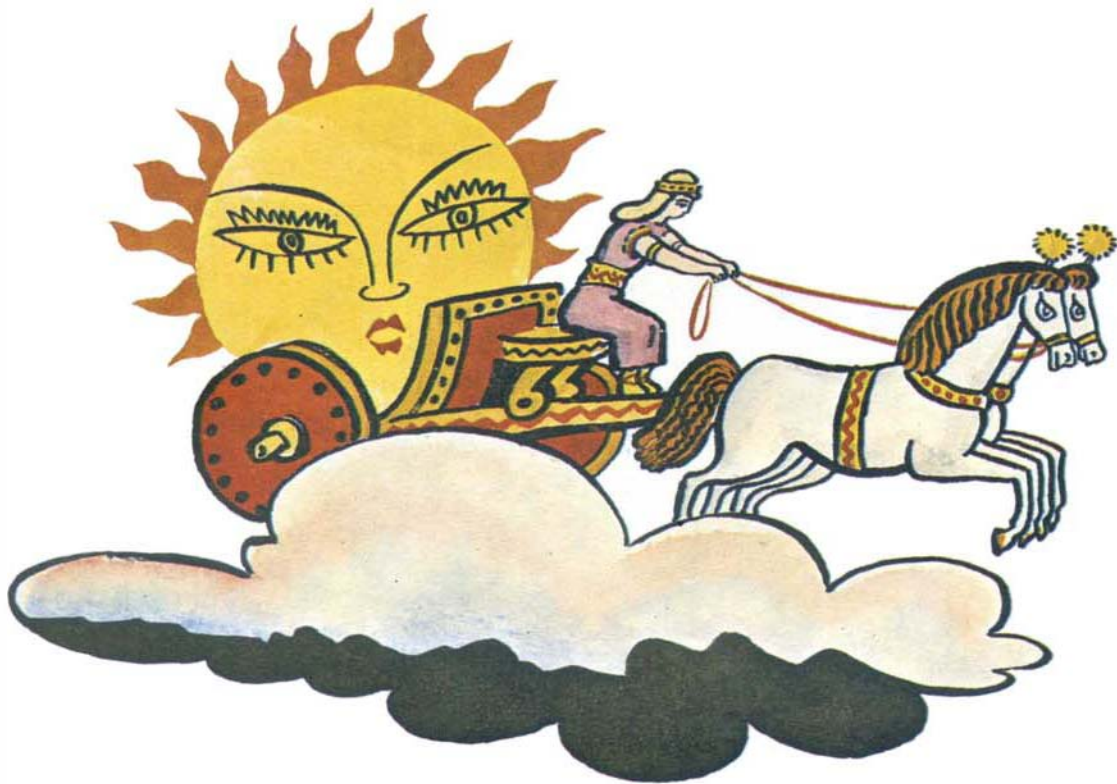
A slight breeze was blowing. The East flared brighter and brighter. Then Eos, the dew-fingered goddess of the dawn opened the gates through which Helios, the radiant sun god would soon appear. Attired in bright saffron the goddess of the dawn flew on pink wings to the

dawning sky which was flooded with pink light. The goddess sprinkled dew out of a golden vessel onto the Earth and the dew fell on the grass and flowers in sparkling diamond drops. Everything smelt fragrant on Earth. The aroused Earth joyfully greeted the rising sun god, Helios.

The radiant god came out into the sky from the shores of the Ocean on a golden chariot, drawn by four winged steeds and created by the god Hephaestus. The mountain tops were lit by the rays of the rising Sun. The stars ran from the horizon at the sight of the sun god and hid one by one in the bosom of the dark night. The chariot of Helios rose higher and higher. Decked in a shining crown and long shimmering robes he crossed the sky, flooding the Earth with powerful rays and giving it light, warmth and life.

When he had reached the end of his day's journey, the sun god descended into the sacred waters of the Ocean where he was awaited by a golden boat which returned him to the country of the Sun and his wonderful palace in the East. The sun god rested there at night to rise





to his former glory on the following day.

And here is a tale which was composed by the inhabitants of the severe northern Scandinavian countries.

Once long ago there was still no Sun or Moon and the Earth was shrouded by eternal night. And because there was no Sun, the trees and flowers did not bloom and luxurious green grass did not grow in the fields.

Then a powerful god called Odin went with his brothers to the country of fire, took some flames and made the Sun and Moon, which were more beautiful than anything the gods and magicians had ever managed to make. Someone had to be found to drive the Sun and Moon across the sky.

At that time there lived on Earth a man who had an extraordinarily beautiful son and daughter. The father was terribly proud of his children and considered that there could be nothing more beautiful on Earth.

When he heard about the gods' amazing creation, he called his daughter Sól, which meant Sun, and his son Máni, which meant Moon.

The gods were displeased by his audacity and cruelly punished him.

Odin took Sól and Máni into the sky and made them drive the Sun and the Moon.

Ever since then Sól has sat in the front seat of the chariot, driving a pair of white steeds. Each day she drives the Sun across the sky and only has time to rest a little at night.

Her brother, Máni, drives the Moon on another chariot at night.

Since then crops have grown in the fields, fruits have ripened in orchards, green forests have flourished on the hills and people have rejoiced and thanked the gods.

But the brother and sister sometimes cry with shame. Then the Sun and Moon in the sky are shrouded by mist.

But does the Sun really move? Why does it rise and set and not stay in the same place in the sky?

Do you remember riding one evening on a merry-go-round beside an enormous bright light? The light appeared in front of the merry-go-round, rushed past and again hid behind the merry-go-round. For a while the light could not be seen in the dark and then it appeared again, moved past, shining on you, and disappeared again.

But, in fact, the light did not move at all. It was shining in the same place all the time, but the merry-go-round was revolving, hiding you from the light and then returning you to it again.

It's the same with people on Earth. The globe does not simply fly in space around the Sun: it flies and spins at the same time like a merry-go-round, hiding us from the Sun and then bringing us into the sunlight.

It seems to us that the Earth is standing still and that the Sun is moving round us.

This is because the globe is so enormous. Such a huge thing cannot turn quickly like a spinning top: it turns slowly and smoothly, without squeaks or jerks.

It takes twenty four hours for the globe to turn around its axis. That's why we do not notice it turning.

When you cross the sea on a large liner you do not notice it turning.

Of course, if the shore is in sight, you can see when it turns by the land. But what if you can't see the shore? What if the ship is sailing in the open sea? Then you can only tell by the Sun that the ship has changed course. For instance, if you are sitting on the shady side of the deck and suddenly see that you are emerging into the sunlight, you know that your deck is turning towards the Sun.

It's the same with the globe.

Look carefully at the Sun as it emerges from behind a house or hill. The Sun seems to be crawling slowly across the sky, but, in fact, our globe is turning

slowly under the sunrays like an enormous ship.

The Sun only lights up the half of the Earth which faces it. At this time it is dark on the other side. It is night-time there. Then, when the globe turns round, night turns to day and the other way round.

So that you have a better idea of how the globe revolves, we have drawn a line through its axis on our drawing. Of course, there isn't really an axis. We have simply imagined this line.

The points on Earth where this axis should emerge are called poles. The point at the top is called the North Pole and the one at the bottom, the South Pole. The middle of the globe between the poles is called the Equator.

You and I live between the Equator and the North Pole in the upper half of the globe which is called the Northern Hemisphere.

The Earth takes a very long time to fly round the Sun. It takes a whole year to fly round the Sun once. In this time it has spun round its axis 365 times. That is why there are 365 days and nights in a year.

The Moon, like the Sun, rises and sets every day. If you look carefully at the stars, you will notice that all the starry sky seems to be turning very slowly. Look at a bright star. Now it is here and an hour later it will have moved noticeably, but tomorrow at the same time it will again be in its former position.

This happens because the Earth is in constant slow motion. We are sitting on this vast merry-go-round and turning with it. But it seems to us that the world and space are moving around us.

Now imagine that you have sat on the top of the merry-go-round, on its roof where there is usually a flag. The merry-go-round revolves and you look up at the sky. The houses and trees rush round you but the clouds directly above your head remain still, as if a "nail" has



You and I live neither at the Pole, nor on the Equator, but in between them. That is why the Pole Star is not directly above us but lower. That also explains why in our part of the world the Sun and the Moon rise gently upwards as if climbing a hill, and set as if rolling downhill.

All this happens because the Earth is a sphere which revolves.

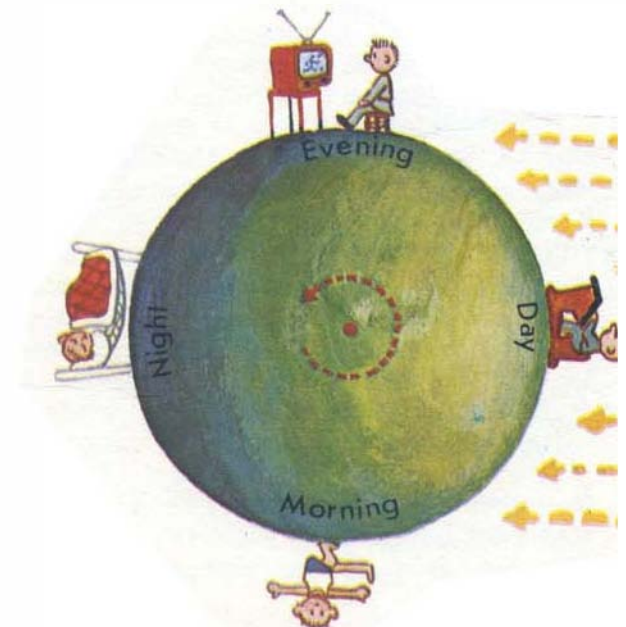
been driven in here and everything else has been drawn on cardboard and the cardboard is revolving on his "nail".

The Earth's Pole is like the roof of the merry-go-round. If you and I were at the Pole, the Pole Star would be directly above our heads. Do you remember we spoke about this star? It is the "nail".

The globe revolves slowly. All the sky above us seems to be turning towards us but the Pole Star remains in the same place.

The starry sky moves in an entirely different way when we move from the Pole to the Equator. From here the Pole Star seems to be lying motionlessly on the horizon in the direction of the North Pole. If we stand on the Equator and look towards the East, the starry sky rises majestically like a huge curtain in a theatre, and the stars descend just as sharply towards the horizon in the West.

It is interesting to watch on the Equator how the Sun and the Moon set. Like the stars, they descend very sharply, as if someone had dangled them on a thread and then dipped them behind the horizon.





Why Is the Sun Hotter in Summer?

Why is the Sun hotter in summer than in winter? Perhaps the Earth is nearer to the Sun in summer? If this were so, the Sun would look larger in the sky in summer than in winter. All objects look larger close-up, and smaller in the distance. The Sun is always the same size in the sky in winter and summer alike.

It doesn't seem to matter how far away the "stove" is which warms us.

Do you remember where the Sun is in the sky in summer and in winter? In summer it climbs higher. The higher the Sun is in the sky, the hotter its rays become. It's hotter in the afternoon than it is in the morning, isn't it? What's more, the day is much longer in summer than in winter. In summer the Sun rises earlier and sets later. On a long day the summer has time to thoroughly warm the air, the Earth, you and me. That's why in summer it's warmer than in winter.

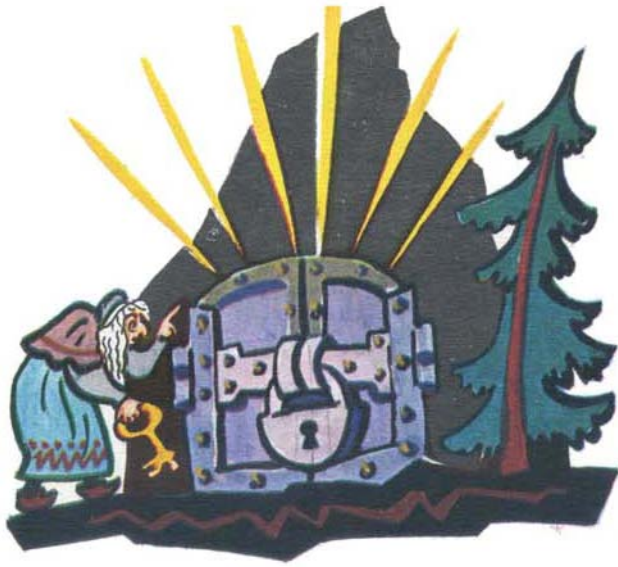
The summer is followed by autumn. Every day the Sun sinks lower in the sky.

It rises later and later and disappears below the horizon earlier and earlier. Every day it sends us less and less heat and light and it becomes colder and darker all the time.

Winter arrives. In December the Sun appears in the sky for only a few hours and you can't always see it. It's very low in the sky, hiding somewhere behind the houses and trees.

It's even worse in the northern countries where the Sun becomes even weaker in winter and hardly rises above the horizon. By mid-December it is no longer able to rise at all and the sky only lightens for about an hour at the most. Then night returns and a few days later the sky ceases to grow light. For a few weeks it's pitch-black, cold and gloomy.

And no matter how much you calm yourself, each time you feel frightened. What if the Sun has left us for good? What if the darkness and cold never end? How will we live then? Where can we get help?



In the past people felt even more terrified. They had no books or schools. They were ignorant and had no one to ask.

They looked sorrowfully at the departing Sun, black cliffs and slumbering winter forest, and composed tales.

In these stories the northern country from which the Sun vanished for a long time in winter became known as Pohjola, a severe country of darkness and cold which was ruled by Louhi, an evil old witch.

Not far away, in the sunny country of Kalevala lived three good magicians.

The first was wise, old Väinämöinen. He sang songs so well that even the woodland animals and birds gathered to listen to him.

The second was Ilmarinen, an indefatigable and very skilful blacksmith.

The third was Lemminkäinen, a fearless and jovial hunter.

Our heroes were attracted by the harsh country of Pohjola because old Louhi had a very beautiful daughter who sat in the sky on a rainbow, weaving golden cloth on a silver loom.

Our heroes wooed the beautiful girl in turn but she turned them down.

The old woman mocked the suitors and made them undergo various tests, one more difficult than the other and then chased them away. The greedy old witch finally gave her daughter away to Ilmarinen the Blacksmith because he made the magic Sampo mill for her. You didn't have to pour anything into this mill or turn it. It turned by itself and produced everything that Louhi wanted: flour, salt and, if necessary, money.

Ilmarinen took his young bride home but she turned out to be bad-tempered, evil woman. One day she put a stone into her shepherd's bread. The shepherd was offended and turned his herd of cows into a pack of wolves and the wolves tore the evil woman to shreds.

Then the heroes decided to take the magic Sampo mill away from old Louhi, for she hoarded all the riches for herself and the mill could have brought happiness to everyone in the world.

All the warriors of Pohjola came out to meet the heroes but Väinämöinen began singing and the warriors fell asleep. Then the heroes opened the old woman's store-room, took the Sampo mill and carried it away on a boat across the sea home.

Meanwhile the old woman awoke and saw that her mill was missing. Shaking with fury, the witch chased after the heroes. She cast a mist over them which shrouded the boat but the heroes were not afraid. Väinämöinen unsheathed his sword and cut through the mist. Then the evil witch cast terrible waves against the boat, but the heroes steered away from them. Then Louhi summoned the winds to her aid. They pounced on the boat in a storm, but the valiant heroes managed to deal with the storm.

The enraged old witch roused all the people of Pohjola to pursue the hateful strangers. There was a fierce battle but the heroes, nevertheless, remained alive.

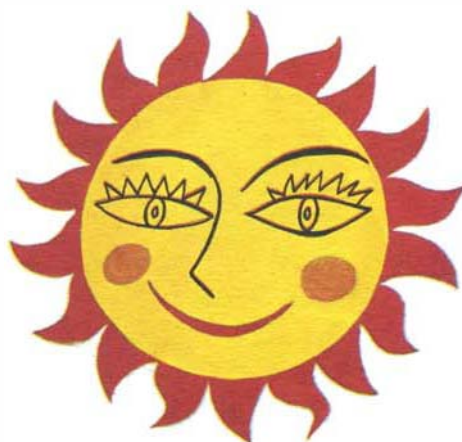
But the Sampo mill fell into the sea and was smashed against the waves, but wise old Väinämöinen gathered up the fragments, assembled them in a clearing and said: "Let there be happiness in the land of Kalevala."

And immediately the wind stopped trampling on the crops in the fields, the frost stopped destroying the young shoots and the storm-clouds stopped covering the Sun.

Then the old woman decided to wreak the most terrible vengeance on the heroes. She worked out a plan which no one could resist.

She chose the time when Väinämöinen was singing songs in the wood. He was singing so well that even the Sun and the Moon had sunk lower and settled on the shaggy branches of the pines to listen.

Then the evil old woman stole up, grabbed the Sun and the Moon, dragged them home and locked them in her cellar.



It became dark and cold. The Sun no longer rose and nothing warmed the frozen Earth. Even the Moon no longer lit up the mountains and forests.

Bad times fell upon the country of Kalevala. People began to be overpowered by the darkness and cold. It was hard without the Sun. Oh how hard!

But although the old woman had avenged the heroes, she still felt afraid. She turned herself into a hawk and flew to see what the heroes were doing in the cold and darkness. Had they already died or were they still trembling with fear?

She flew down and what did she behold? She saw Ilmarinen the Blacksmith, safe and sound, making something in his smithy. "What are you making?" she asked. "I'm forging a collar for evil old Louhi," said Ilmarinen, "I want to put her on a chain and bind her to a rocky cliff on a copper mountain."

The old woman realised that she was powerless before the heroes. Even the worse possible thing on Earth—eternal darkness and cold—had not killed them. She flew gloomily home to Pohjola, opened the cellar and released the Sun and the Moon.

And it became light and warm again in the country of Kalevala.

And now people are no longer afraid when the Sun hides behind the mountains in winter. The evil witch and sovereign of the severe country of Pohjola





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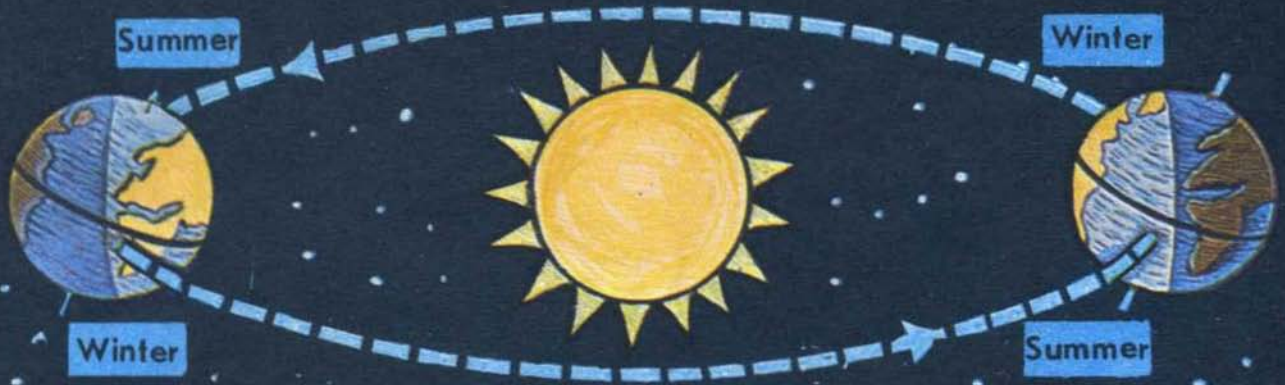
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has been vanquished. She was defeated by a man who was neither afraid of the darkness nor of the cold.

It's a beautiful story, isn't it?

But now let's see why it is that the Sun does not cross the sky in winter and in summer in the same way. After all, the Earth always revolves in the same way.

This is caused by the Earth's axis which is, in fact, tilted. That explains

why the Earth does not revolve in an upright position like a merry-go-round, but slightly tilted to one side. What's more, the Earth is always tilted to the same side. This explains everything.

In our drawing the Earth's axis is tilted to the right. The Earth flies round the Sun with its upper half, the Northern Hemisphere, sometimes tilted towards the Sun and sometimes away from it.



Let's see what happens when the Northern Hemisphere is tilted towards the Sun.

The Earth turns slowly with us on it. When we approach the border between light and darkness, we see the sunrise. "Morning" is written on this spot in the drawing.

Then we travel all day under the Sun's rays on our merry-go-round Earth. At midday the Sun is almost directly above us in the sky.

A little while passes and then the Sun goes behind the horizon. It stops giving us light when we come to the word "evening".

Now look how short the night is.

What a long time in summer we spend under the Sun's rays and what a short time we spend in the shade.

It's because the day is so long that the night is short and because the Sun shines

directly from above that it gets warm. Summer is coming.

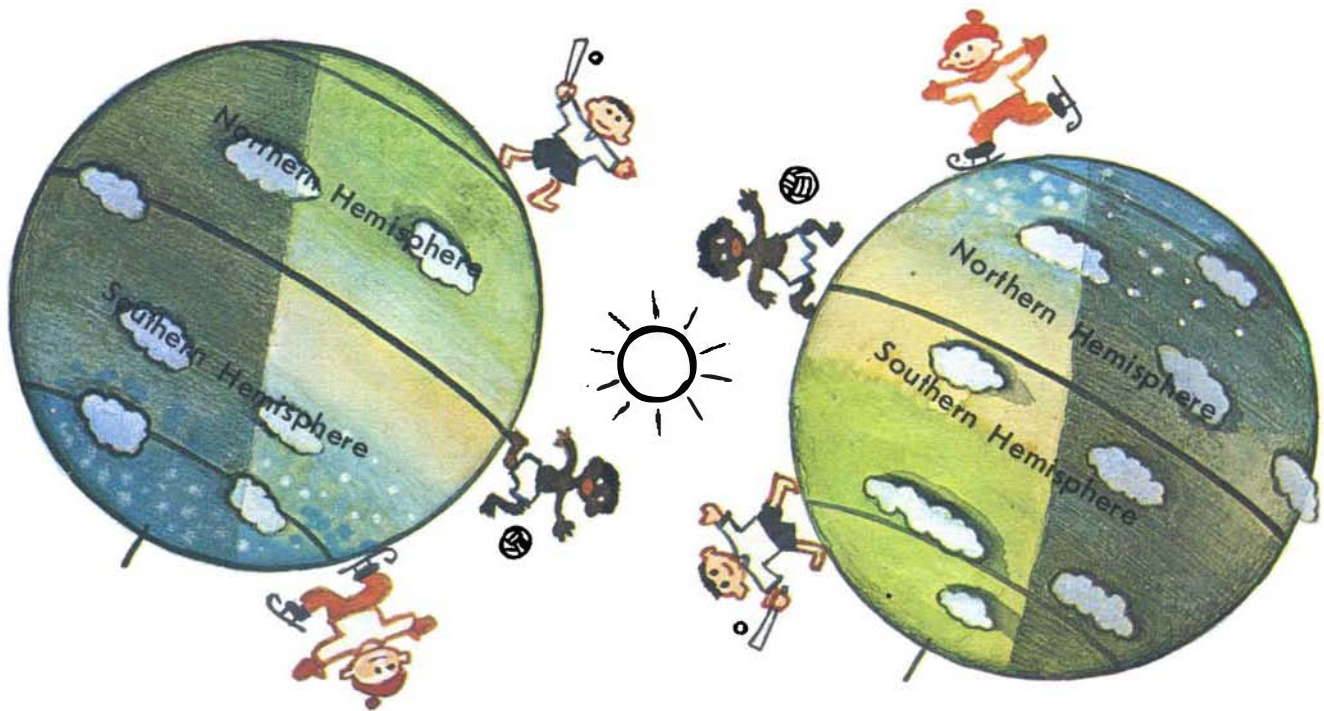
It's completely different when the Sun moves across to the other side of the globe. The Northern Hemisphere is now tilted away from the Sun and not towards it. Each time the Earth turns round we have to sit in the shade for a long time. The merry-go-round Earth takes us into the sunlight for only a few hours and then returns us to the shade for a long time.

The night becomes long and the day is short. In the day-time the Sun no longer shines on us from above like in summer, but from the side. Its rays become wan and it slides obliquely across the Earth, warming it weakly.

It becomes cold and winter arrives.

If we lived somewhere nearer the Equator, for example, in India, we would never feel cold or put on a coat. There





the Sun shines from directly above and rises very high all the year round.

That's why it is always very hot in countries near the Equator. They are called "hot countries" for this reason.

Inhabitants of these countries do not even know what the cold and snow mean.

But there is again a winter and a summer season like ours beyond the Equator, in the lower half of the globe.

The interesting thing is that when we have our summer, it's winter in the Southern Hemisphere. And when we have our winter, they have summer.

You have probably already guessed why this is so. When the upper half of the Earth is tilted towards the Sun, the lower half is turned away from it, and when the upper half is turned away, the lower half is warmed by the Sun's rays.

We are used to January being the coldest month of the year, but in Australia, January is the hottest summer month. There it is autumn in May, winter in June and the buds blossom and everything becomes green in September when spring arrives.

There everything is the other way round because our country and Australia are in different halves of the globe. We are in the Northern Hemisphere and Australia is in the Southern.

These are the interesting things which occur because the Earth's axis is tilted.

But if the Earth were to revolve in space in an "upright position" like a real merry-go-round, everything would be completely different.

The Sun would emit the same warmth all the year round. There would be no seasons. It would always be winter near the poles and always summer near the Equator. And in our part of the world it would always be slushy and something between spring and autumn.

We wouldn't be able to ski on the hills or sunbathe on the beach. It would neither be one thing or the other. We would have to walk in rubber boots and carry an umbrella all the time. It would be very boring, wouldn't it?

We're lucky that the Earth's axis is tilted!



Why Is the Moon a Crescent?

All the heavenly bodies are enormous spheres. That's why the Sun is always round.

But for some reason the Moon is only round sometimes, and most of the time is crescent-shaped.

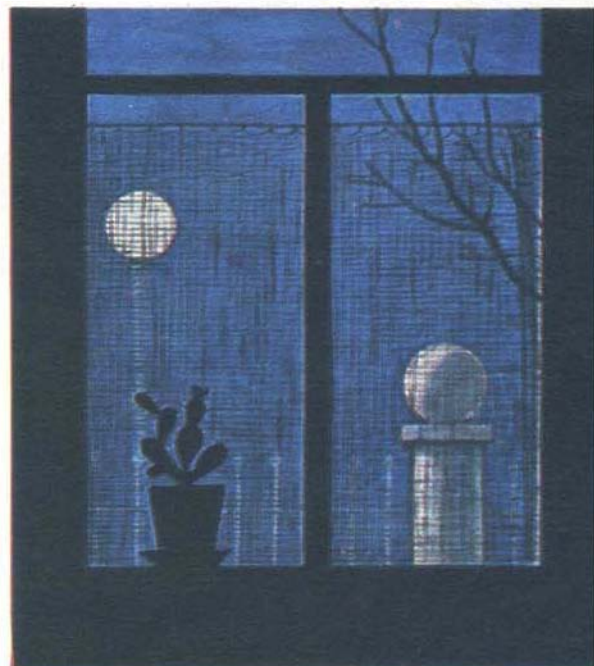
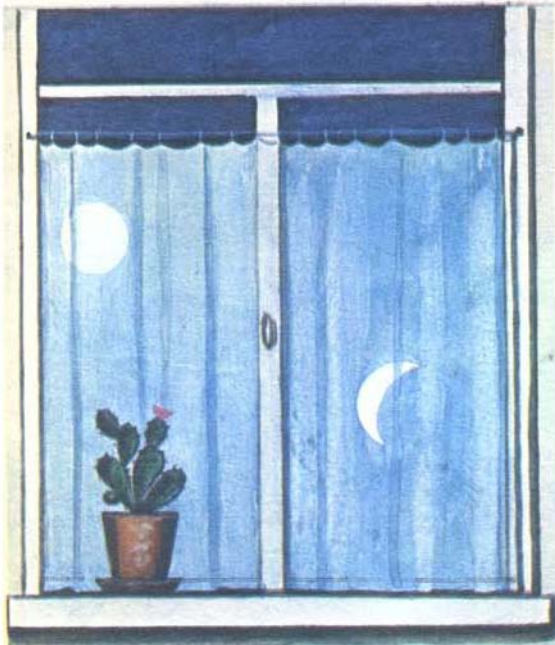
What happens to the rest of the Moon? Where does it disappear to?

Look at the misty light of a street lamp. It looks just as round from any vantage point and emits light like the Sun.

But that stone ball on the fence does not emit light. It is illuminated by the lamp, and illuminated only on one side.

Now look at the stone ball from a room through a lit curtain. You can't see the dark side of the ball, you can only see the illuminated side, a "crescent" which looks like an orange segment.

It's the same with the Moon. The Moon, you see, is also a dark stone ball. The Sun — a lamp which illuminates it on one



side. Only the dazzlingly bright Sun and the half of the Moon brightly lit by the Sun can be seen in the blue sky. The dark side of the Moon cannot be seen. The hazy air hides it and the other stars, but they all are still there during the day. No one switches them off!

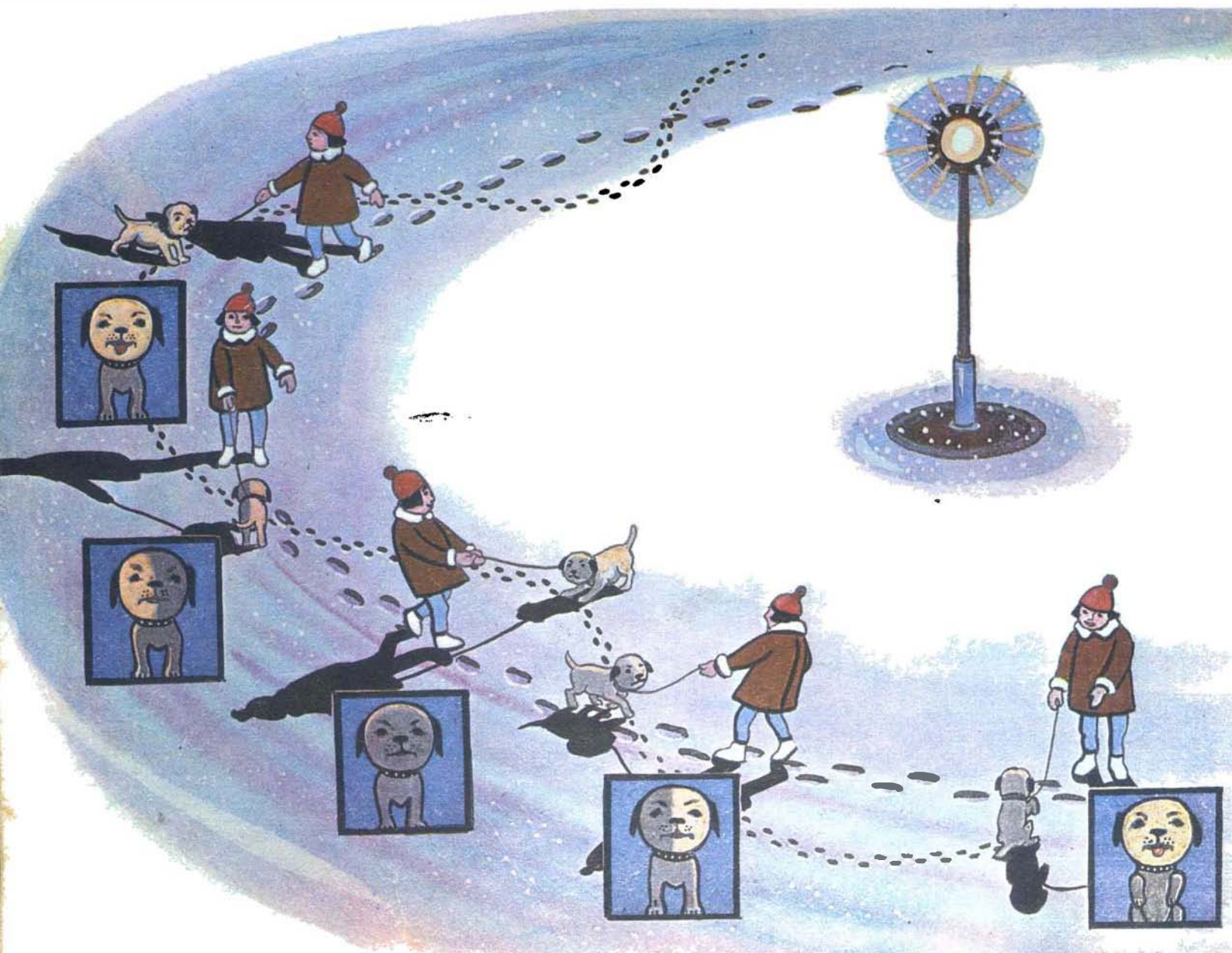
At night the air is in the shade. The Sun does not light it at night. It becomes transparent like a curtain after the light is turned out. Everything can then be seen through it and the stars begin to twinkle.

Sometimes the air at night is especially transparent and free of dust and clouds.

Then you can see the weakest, smallest stars. On nights like this you can also see the dark side of the Moon.

Why is the Moon sometimes round, sometimes a thick crescent and sometimes a thin crescent like a sickle? Because it revolves around us. It is like the puppy on the lead in our drawing.

Sometimes the puppy's face is brightly lit up and sometimes only half-lit up. When the puppy runs towards the lamp and stands opposite the light, all its face is in the shade and you can only see its delicate, bright sickle-like silhouette shining like the Moon's.





What Is on the Moon?

We already know that the Moon is an enormous stone sphere. It floats majestically round the Earth in space.

It was impossible for people to imagine what the Moon was really like before telescopes were invented. They just gazed at it, trying to guess.

Everything seems mysterious in the silvery blue moonlight. The trees are silent and the pond sparkles in the moonlight.

The Moon is the fairy-tale queen of the night and many stories have been composed about her.

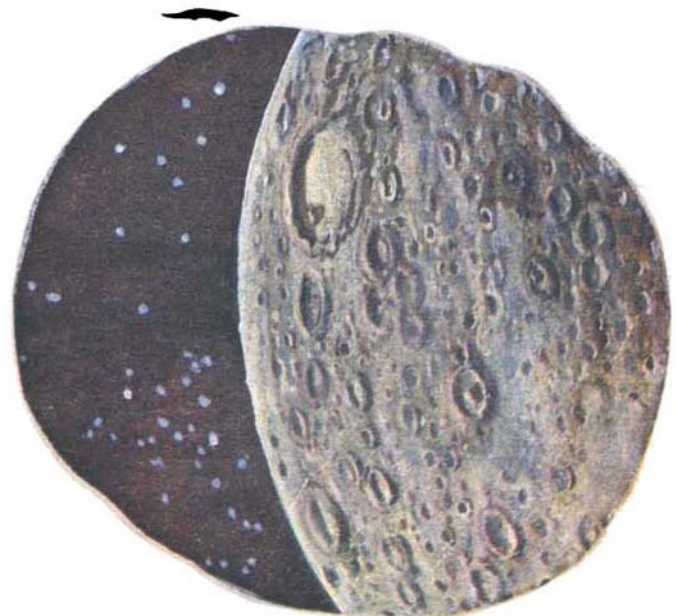
The following story is told in Kirghizia, in the south of the Soviet Union.

Once upon a time there lived a rich Khan who had a beautiful daughter called Moon.

Many foreign suiters offered fair Moon their hand and heart and wanted to take her for their bride but the Khan's daughter rejected them all because she loved a poor sailor and he loved her.

But the Khan would never give his noble daughter away to a common sailor. Then the young man decided to set off for a distant country, accomplish a great feat and return a hero. The Khan then would not dare refuse him.

The sailor bid farewell to his love and sailed far away across the ocean and the beautiful girl began to wait for him.





A long time passed and her love still did not return. Moon began to grieve and go out to the shore at night to see if the sailor was coming.

But he never came. Perhaps something had happened to him? Moon cried and pined away.

The old Khan died and his daughter was left alone in the splendid palace.

Every night she put on her bridal gown, and slowly drifted in a magic boat across the sky with her companions, the stars. She gazed sadly into the distance, in search of her lost love.

That is why the Moon is pale and sad.

In another very old tale the Moon was a magic silver island floating in the blue ethereal ocean, which was inhabited by wonderful unhuman-like beings.

But in most tales the Moon is a living creature. For it's true that when you look at the Moon, it seems a funny smiling face is looking down at you from the sky. The dark spots on the Moon are very like a mouth, nose and eyes.

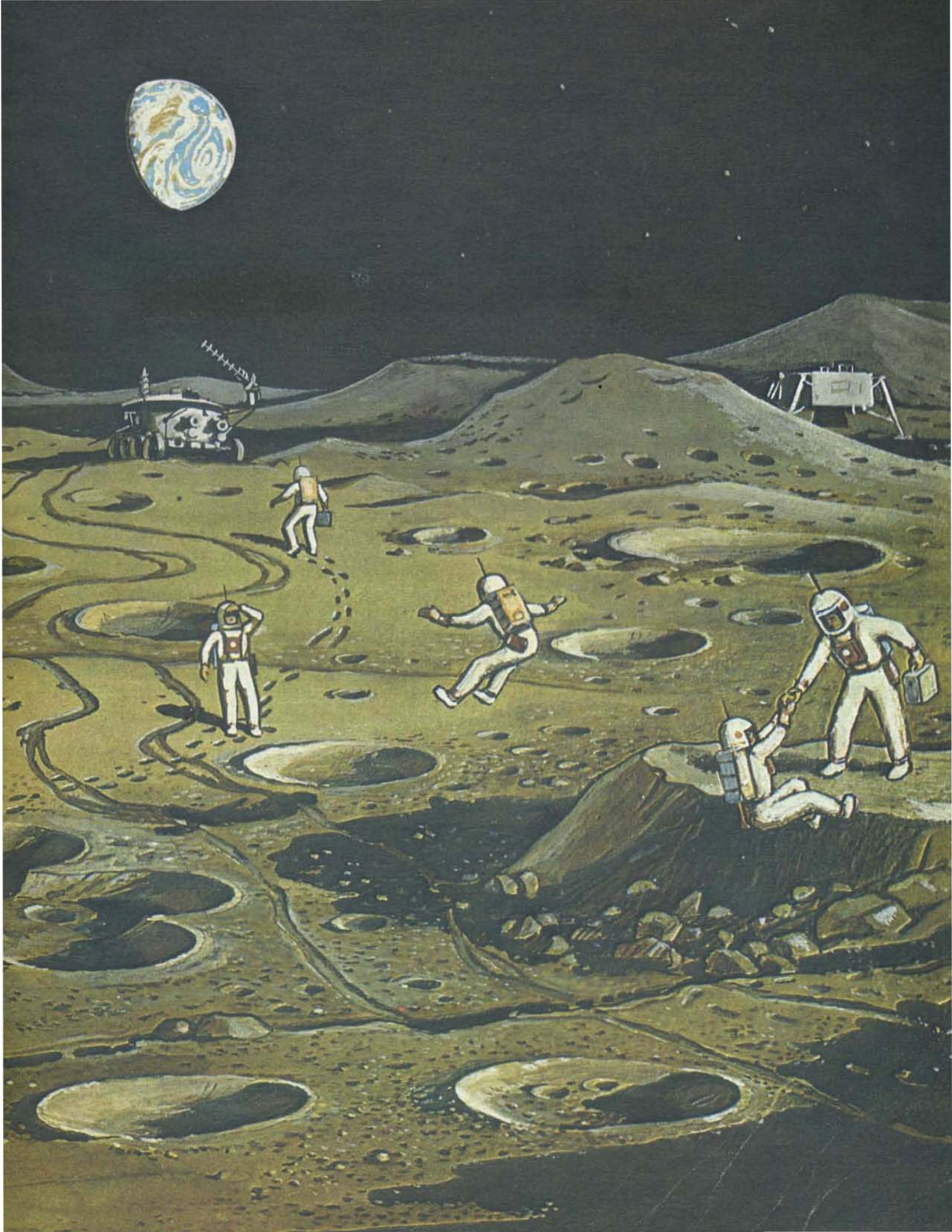
People could see and examine the Moon well enough through a telescope but they wanted to look at it in greater detail.

They began to send various automatic devices in rockets to the Moon which examined everything around them through glass lenses and relayed this to Earth by television.

The first automatic devices could not move. They landed on the Moon and stayed in the same spot. They could only turn their "heads". Then scientists and engineers began to send more "intelligent" automatic devices to the Moon. Among our Soviet automatic devices that landed on the Moon, there were some, for example, which stuck out a long steel "arm", gathered a piece of moon rock and put it in a small rocket capsule, which then took off from the Moon and returned to the Earth. Thus, "pieces of the Moon" were delivered to the scientists' "door-step", so to speak. Other of our automatic devices had wheels and engines. The *Lunokhod* examined the locality and relayed pictures of the findings by television to people on the Earth. It was controlled by radio from the Earth and went in any given direction across the Moon. Scientists and engineers sat in comfortable chairs in a room on the Earth, watched it on a television screen and they felt as if they themselves were moving across the Moon. They could even order the *Lunokhod* to stop and touch a rock with its "arm" to find out if it was hard or soft and find out its content. All this was incredibly interesting, very practical and quite safe for people.

The automatic devices communicated many new and important facts about the Moon. But the Americans, nevertheless, wanted to send their astronauts to the Moon. They set themselves the most complex task and prepared for it over many years. Two dozen enormous rockets, each the size of a thirty-storey house, were built. The large *Apollo* space-ships were positioned on top of these





rockets. They carried out many test flights around the Earth and then flew to the Moon.

In 1969 the American astronauts Neil Armstrong and Edwin Aldrin were the first people to set foot on the Moon. All in all twelve American astronauts have been on the Moon and the last of them even went across the Moon in space "buggies".

The American astronauts brought back many rock samples and photographs from the Moon, and, more importantly, told of their impressions. After their flights and our *Lunokhods'* work we can now fully imagine our journey to the Moon.

The rocket takes us there in two days.

We've arrived on the Moon! We get out of the rocket in spacesuits. We have to wear them because there is no air on the Moon, it's impossible to breathe, but there's air inside the spacesuit.

The Moon is smaller than the Earth and its pull is weaker. Everything is six times lighter here. You can lift your friend with one hand as if he were a teddy bear.

We're so light here that we can easily jump across wide ditches and leap onto high rock ledges in one bound. It feels as if someone invisible is holding us up all the time. You don't fall here like you do on the Earth: you slowly drop as if plunging into water.

Neil Armstrong said that if you accidentally fall face downwards, you won't hurt yourself, and you can get up by pressing on the ground with both hands. He also said that being lighter got in his way sometimes.

A light person's feet grip to the ground weaker and slip like on ice. If you stand still and then want to start walking, your feet "skid" first. You have to walk in small steps and gradually gather speed. Also, when you're walking fast, you can't stop suddenly or turn sharply.

Your feet slip and you keep going forwards. You have to gradually come to a halt.

It's always perfectly quiet on the Moon. No matter how much you shout, no one will ever hear you. Sounds are carried through the air on the Earth. There is no air on the Moon. You can ring a bell right under your ear and still hear nothing, as if you were ringing it through a pillow. You can only talk to one another by radio or by sign-language.

What can you see around you?

There's no grass or trees here—only desert and uneven ground, as if lots of boulders have been dumped on the Moon, levelled out slightly, and greyish-brown dust has been scattered on top. There are stones, sticking out and holes everywhere. If you don't watch out, you'll trip!

The holes on the Moon are mostly round and have raised edges like shell-holes made by exploded mines in a war. The large holes, called craters, are encircled by hill-ridges. The bottom of the large craters is round and flat which is why they look like a huge stadium with stands or a gigantic open-air circus.

The sky above the Moon is not at all like the sky above the Earth. It is not blue but black all the time, day and night. At night, however, it is studded with stars. You can see them in daytime, too, but only if you shield your eyes from the Sun and the brightly lit plains on the Moon.

You can see the Sun and the Earth in the black sky. It is vast and blue and seems to be smeared all over by something white—our clouds.

Strangely enough, the Sun moves in the sky but the Earth stays in the same place. This is because the Moon always looks at the Earth from one side, like the puppy looked at the girl as it ran round her on a lead; do you remember?

The Sun lights up the Earth from one

side, which is why the Earth looks like a sickle. The closer the Sun moves towards the Earth, the finer the sickle becomes. When the Sun moves past the Earth, it looks like a beautiful silver ring.

The Sun slips very slowly across the Moon's sky. The day here lasts two whole weeks.

During this long day the Sun has time to scorch the rocks so much that you can

cook a meal on them like on a stove. That's very convenient, isn't it?

But watch out when the night comes! It also lasts two weeks here. All the rocks cool down very quickly and freeze hard. In a few days the temperature drops to -150°C ! And the Sun won't come out soon! In this kind of "weather" it's better to stay inside by the fire. It's unpleasant and even frightening on the Moon.



What Are Planets?

It's evening. The Sun has reached the horizon and it's getting slightly dark but the sky is still quite light and rosy blue.

And all of a sudden a silver star begins to shine to your left and above the Sun. It gradually becomes brighter and brighter. There are no other stars yet. How can there be! It's still light. But this solitary star glows like a little lamp and does not even twinkle.

When it has just turned dusk, the star becomes dazzlingly bright. It slowly descends as if afraid to part with the disappearing Sun. When it is quite dark and thousands of stars are gleaming all over the sky, our beautiful star vanishes behind "the edge of the Earth".

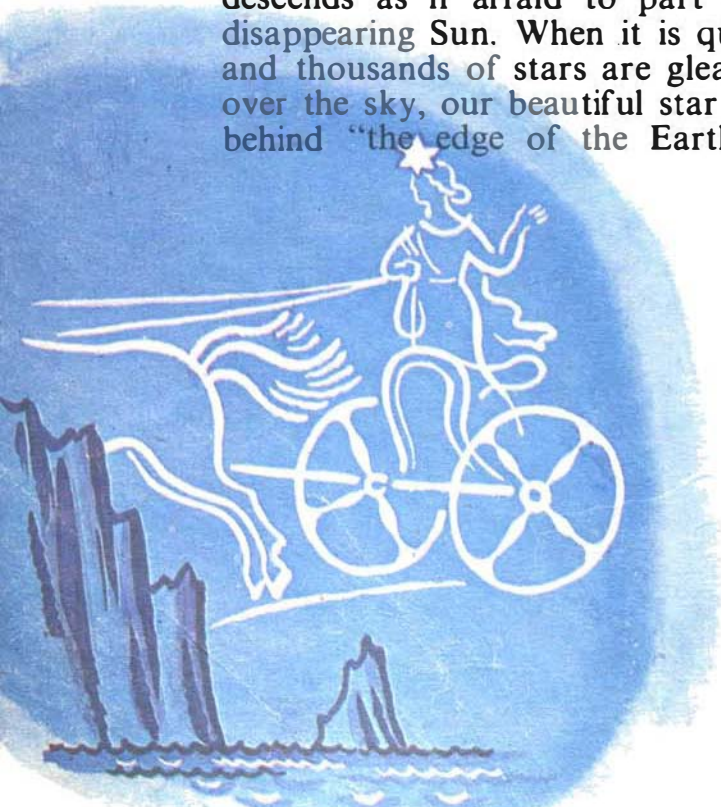
But it appears again the next evening.

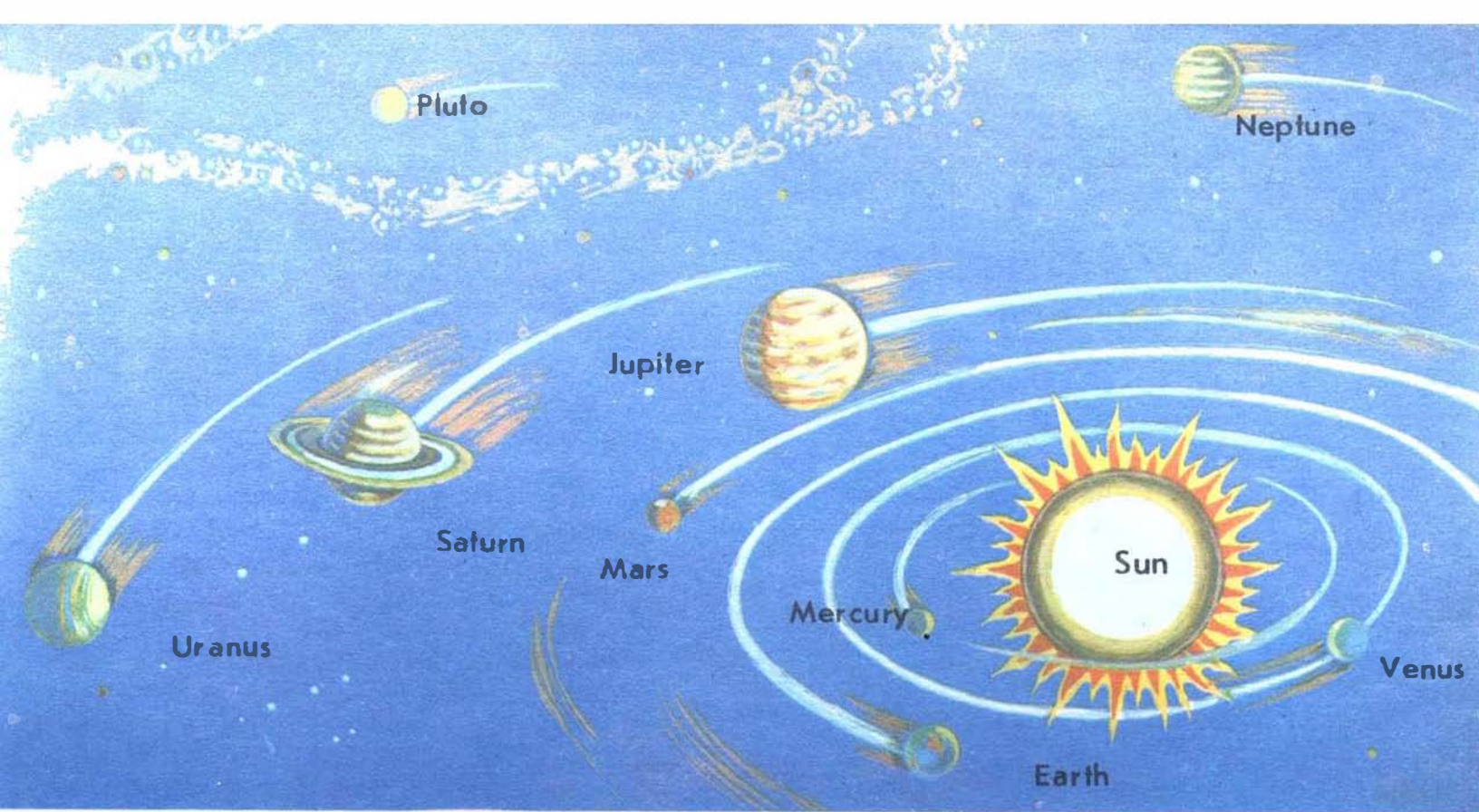
Two months will pass in this way and then the star will gradually become weaker and vanish completely, but a while later it will appear again in the sky in the mornings in the rosy sunlight of the morning dawn. It will rise in the sky, as if pointing the way to the Sun which is about to rise. All the stars have disappeared long ago but this one is still shining. But as soon as the Sun has risen a little higher, it will vanish, too.

What is this beautiful silver star? Why is it much brighter than all the other stars? Why does it wander across the sky, guiding the Sun or following it?

For thousands of years people have gazed in wonder at it and called it either the Evening or the Morning Star. In ancient times people called it Venus after the goddess of beauty and composed beautiful tales about it. They thought that it was a beautiful maiden crossing the sky on a silver chariot driven by snow-white steeds.

What is Venus really? It's not a star, it's a planet. The word "planet" in Greek means "wanderer". All the stars always





shine in constellations in the same place, but some stars slowly “wander” from one constellation to another. If you remember their position by the stars nearby and check after a few days, you will at once notice that your star has “crept away”.

With the naked eye people could see five “wandering stars” — planets. Through a telescope you can see more of them.

Let’s get to know them. But first let’s fly on in space.

Imagine that we have flown far away from the Sun in a huge rocket. We have flown so far that the Sun no longer looks like a big yellow disc, but simply like a very bright star.

And this bright star floats slowly and majestically in space among stars which are even farther away.

Now let’s look carefully towards the Sun. We can make out a few tiny stars near it. They accompany the Sun, encircling it on all sides.

Let’s look at them through a telescope. It appears that you can see a “crescent”

of each star, like a small Moon because they are not fiery spheres like the stars, but dark, solid stone spheres, illuminated by the Sun.

Some are nearer to the Sun than others and our Earth is in their midst.

Planets do not emit light. They only “shine” in the bright sunlight. They are like the Moon.

If the Sun were to go out, all the planets would immediately do so, too.

Let’s see how the planets move. They all revolve around the Sun but from here they seem to be moving terribly slowly. You might even think they were standing still. We have drawn the course followed by each planet during the year.

Mercury, a “swift” planet, revolves round the Sun as many as four times a year. Venus, a more “sedate” planet, only revolves round the Sun twice, and the Earth, once. “Lazy” Mars only does half a revolution, and the rest even less.

The planets will never collide with one another. Each has its course, circuit



or, as it is called, "orbit" in space.

None of the planets will ever leave the Sun. They all are bound to the Sun forever. They all are part of one big happy family. This family is wonderfully well organised. The Sun is the head of the family and that's why the family of planets is called the Solar System.

Now let's turn back and fly to the very "heart" of the planets. Let's land on our Earth and take a look at the other planets from it. Some are nearer to the Earth than others. Some are on the Sun's side and others are on the opposite side.

But they all are very far away. That's why none of the planets look like the Moon in the sky. They all look simply like bright dots which explains why they may be mistaken for stars.

Of course, you can see the planets nearest to the Earth best: Mercury, Venus, Mars, Jupiter and Saturn. Through a good pair of binoculars beautiful Venus looks like a tiny sickle, similar to the Moon. And you at once realise that this is not a real star, but a dark

sphere illuminated by the Sun on one side.

Mercury is more difficult to spot. It moves very close to the Sun, and the Sun's rays are so bright that it's difficult to make out. The small bright star, Mercury, can only be seen for a short while in the rays of the setting sun. It hurries after the Sun, as if afraid to fall behind it and quickly disappears over the horizon. Sometimes Mercury, like Venus, can be seen in the mornings. It pops over the horizon in the spot where the Sun is about to rise, climbs a little higher and in half an hour dissolves in the rays of the dawn.

Mercury is rather "flighty": of all the planets it is the swiftest and most agile. It pops out here and there, quickly appearing and disappearing.

The Ancient Greeks used to say that people who had to hurry somewhere should learn from Mercury. That's why all travellers and wayfarers considered Mercury their patron. Merchants did so, too. You see, merchants were always hurrying to deliver their goods as quickly as possible. The faster you delivered them, the faster you'd sell them and the faster you'd make money. So, Mercury also became the patron of trade.

It is easy to tell Mars apart from the other stars by its colour. Among the bluish-white stars Mars seems bright orange. To see for yourself, remember its position in the sky by the stars nearby. In a few days' time you'll notice how it has moved.

In colour Mars is similar to a flame or a bonfire. Looking at this orange planet, people unwittingly remembered the fires which destroyed their homes in times of war.

People feared Mars. They believed that when it appeared in the sky, it brought wars and disasters upon them.

On the other hand, military leaders considered Mars their protector and hoped that it would help them to conquer the enemy.



You can't see Mars every year. It revolves round the Sun twice as slowly as the Earth. Quite often our planet Earth is on one side of the Sun when Mars is on the other.

It cannot be seen then because of the bright Sun. You can't even make out a bright star next to the Sun in the blue sky during the day, can you? Of course, not. However, when Mars is on our side, it is clearly visible at night. Sometimes it comes very close to the Earth and then becomes large and bright.

We can only see Mars at night. You should look for it in the part of the sky which the Sun passes through in the daytime.

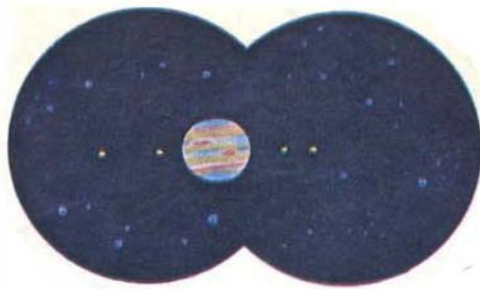
Jupiter can also be seen sometimes in this part of the sky at night. It is a dazzlingly bright white star. Unlike real stars and like all other planets, it does not twinkle but shines evenly like a little lantern.

It's very interesting to look at Jupiter through powerful binoculars. You can then see four tiny, hardly noticeable stars lined up on both sides of it. Remember where they are and look again the next day or even, if you can, a few hours later the same day. You'll see that the small stars have changed places. The one on the left is now on the right of Jupiter, and the one which was close to it has now moved away. These are Jupiter's satellites, its moons. They revolve around it, and every time you look at Jupiter, you'll find them in different places.

The one nearest Jupiter moves the fastest.

Jupiter and its moons are very like a "mini-Solar System". So, when you look at Jupiter through a pair of binoculars, you get a very good idea of our family of planets with the Sun in the centre.

Saturn is also like a bright white star but it shines slightly less than Jupiter.



It is the most beautiful planet—you'll see why later on.

If we could gather together the planets and line them up against an enormous ruler, we would see that they are all of different sizes. Some are smaller than our Earth and others are much larger.

Mercury is the smallest planet and Jupiter is the largest, but even Jupiter is many times smaller than the Sun which could not even be fitted on our drawing.

We've drawn the Moon by its side as a guide-line. It is even smaller than Mercury.

Do you see how different all the planets are?

But do you think it makes any difference which planet you live on—on a small one or a big one?

Do you think it's better on a big one? There's more space? Or on a small one? You can get "around the world" quicker?

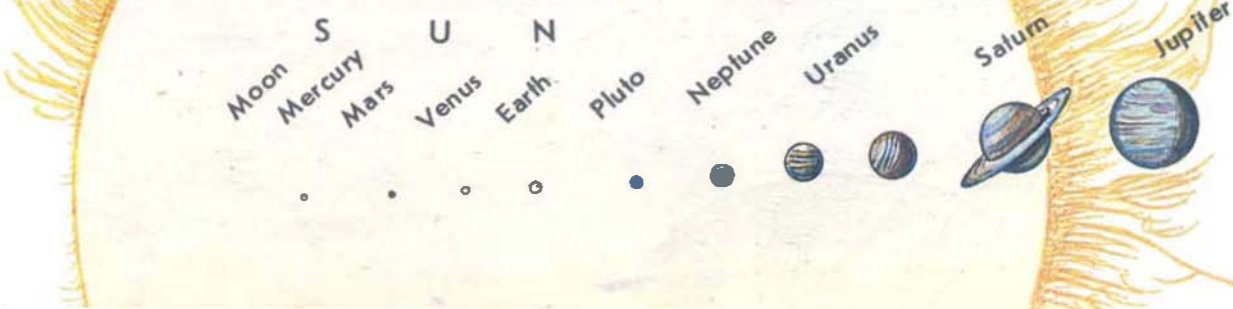
Wait before you decide. It's not as simple as it seems.

The bigger the planet, the stronger it attracts everything. On a big planet everything is much harder to lift because everything seems much heavier.

Jupiter, for instance, attracts things almost three times more powerfully than the Earth. On Jupiter it would not be easy for us to keep on our feet. We would feel as if each of us had been weighed down by several suitcases.

Of course, our legs would give way under such a load.

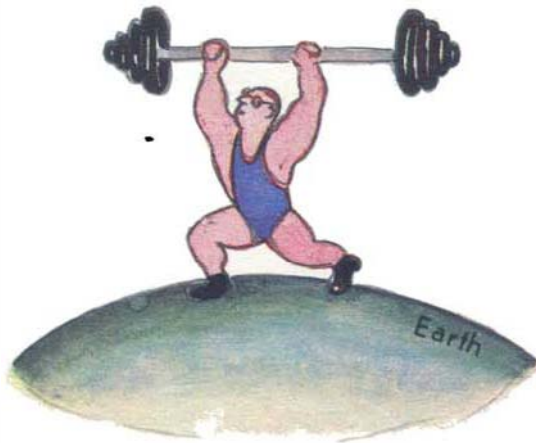
But not only we would find it difficult to stand Jupiter's pull. A brick house





would also collapse on Jupiter because the bricks in the house's foundations would crumble. You see, a five-storey house on Jupiter would weigh as much as a fifteen-storey house.

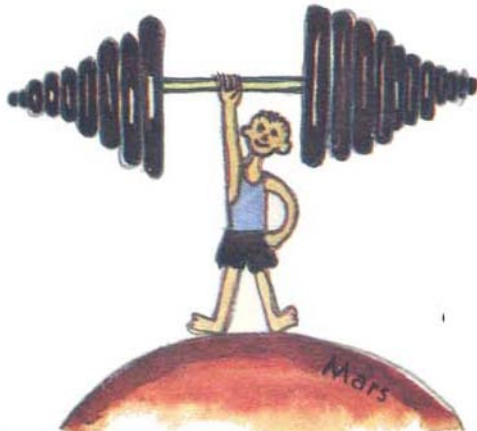
On Jupiter railway tracks would bend under the weight of a diesel train, the



wings of a plane would snap and the springs and wheels of a bus would break.

As you see, it's not easy living on big planets. There you need "reinforced concrete" people, "steel" trees and "stone" animals.

Well, if that's so, it means that life is nothing but a joy on small planets!



Small planets attract things less. Everything there becomes lighter as if suspended by a balloon. You can walk easily, run fast and jump high. Do you remember the Moon?

Don't get excited straightaway!

You see, if people weigh less on a small planet, then stones and everything else weighs less, too. A small planet attracts water and air less.

You haven't forgotten that the Earth is "coated" with air? But have you thought why this air stays above the Earth? After all, if you blow tobacco smoke over a football, the smoke disperses at once, and air is like smoke. It also "wants" to disperse and disappear from the Earth in all directions. Why doesn't it? Simply because the Earth is strong and powerfully attracts the air and keeps it nearby. But if the Earth were to become weaker, the air would immediately begin to disperse in all directions in space like tobacco smoke in a room.

So, the air would really create a problem on small planets. Small planets are not strong enough to keep the air and it gradually disperses.

On Mars there is much less air than on the Earth. It is quite thin there.

There is almost no air on Mercury, and on the Moon, as you know, there is no air at all. It all dispersed a very long time ago.

Air is not the only problem on small planets: water's a problem, too. You see, water evaporates, especially when it is warmed by the Sun. Water becomes steam, mist and clouds. Mist and clouds are already part of the air. If it is attracted weakly, it disperses in space.

For this reason there is almost no water on the small planets.

There's a drop of water on Mars but it has all evaporated on the Moon. There's not a drop of water on the Moon. Even if you take a pail of water to the Moon and pour it onto the rocks, the puddle of water will evaporate very quickly



Can You Land on Mercury?

So, our spaceship is flying towards Mercury.

Mercury does not seem to be revolving but to be constantly flying “on one side” towards the Sun. But this is only an illusion. Look at the spots on the planet. They are “crawling” slowly from the illuminated side towards the shade. That means the brown-tinted sphere is slowly revolving after all.

Mercury flies fast and revolves round the Sun once every three months, but takes six whole months to revolve around itself and warm all its “sides” in the Sun.

Just imagine — Mercury’s days are twice as long as Mercury’s year! That means you can see in the New Year twice in a day on Mercury: in the morning and in the evening, for instance. Only don’t forget that if it’s the morning there when

it’s January on Earth, it will be evening only in April.

It’s a strange planet.

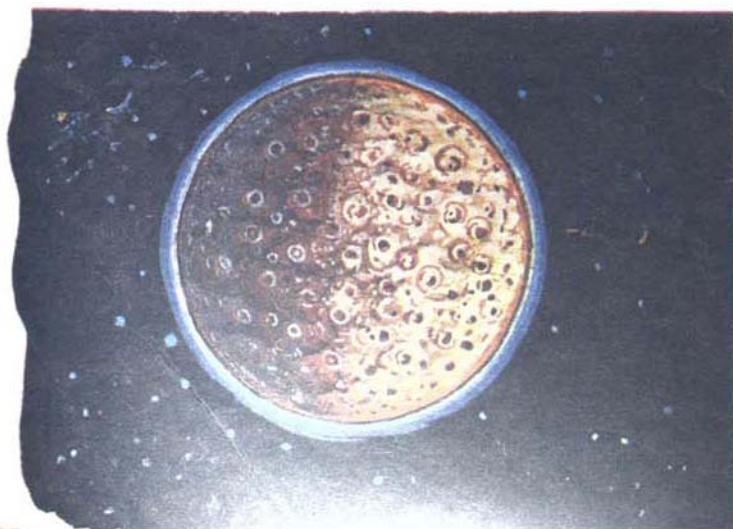
Where shall we land on it?

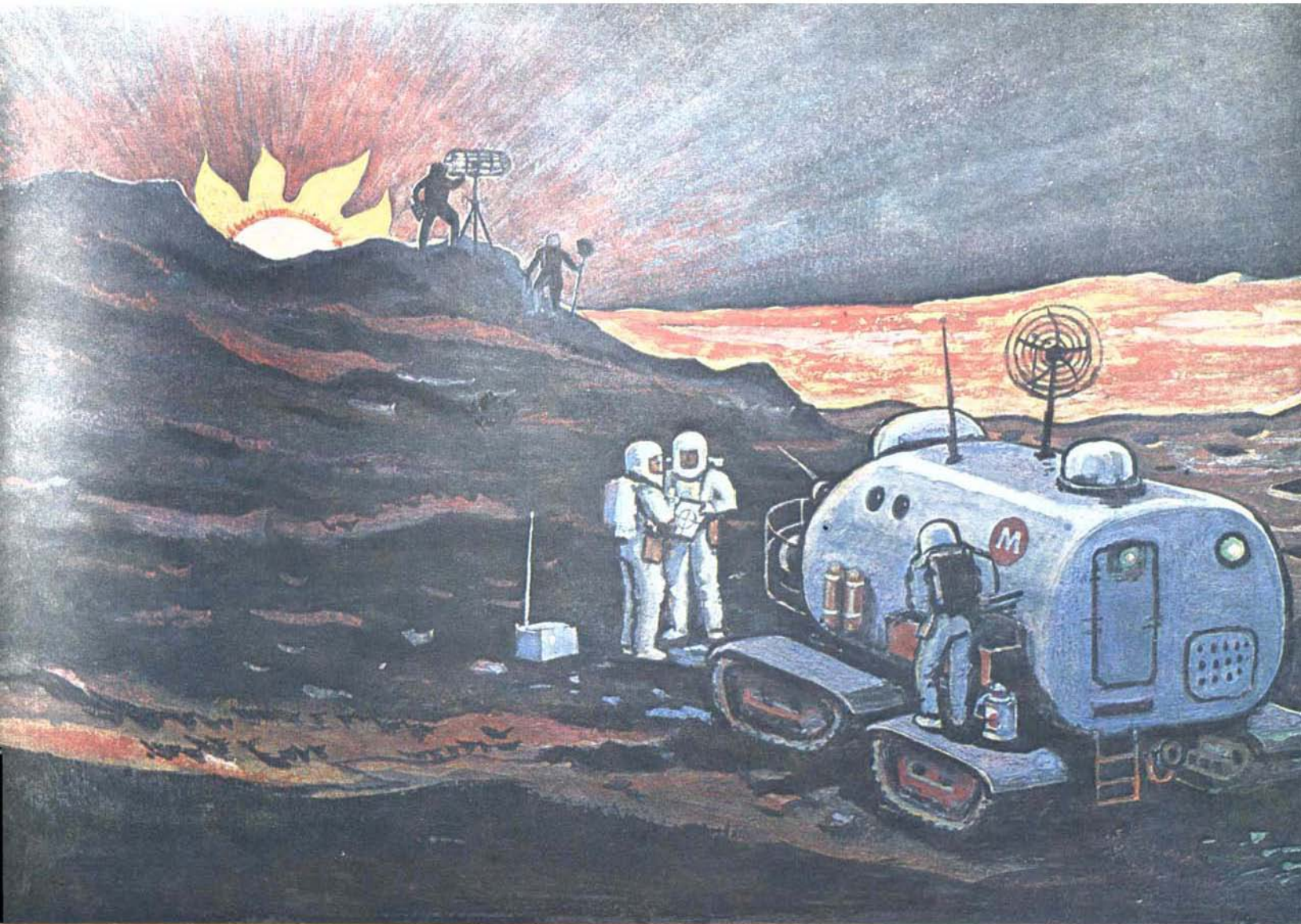
The Sun is very close and looks enormous. It is three times larger from here than from the Earth. It’s unbearably hot. On the illuminated side of Mercury it’s like a furnace, -400°C ! And a hot day like this lasts three months! We can’t possibly land our ship here. We’ll burn! The glass will soften and the lead will melt at such a temperature!

On Mercury all the water boiled and evaporated and almost all the air dissolved in space long ago. There are only dry, bare rocks. In the daytime they are so scorching hot that if you stepped on them, your boots would burst into flames.

At the same time in the shady part of the planet it is pitch-dark night. It is terribly cold: -150°C and sometimes more. The Sun has set over the horizon and will not appear for three months. Mercury does not even have its own Moon. It was not given a “night lamp” by nature. Only Venus, which is much brighter in Mercury’s sky than in ours, shines very faintly now and then on the frozen rocks at night, but when it disappears, it becomes pitch-black.

But you can land safely on this planet





and even go for a walk in a spacesuit, of course.

When the Sun sets the daytime heat cannot immediately turn to nighttime frost. It must gradually get colder. There's a transitional period of time when the temperature is normal and pleasant, say, +15-25°C.

So, we'll land our ship on border of light and shade, between the "furnace" and the "refrigerator", on a narrow strip where it's evening and neither hot nor cold.

After landing, we'll have a look around.

Mercury is very like the Moon! The same gloomy, monotonous plains, holes and rocks and everywhere the same craters surrounded by rings of hills. Only the sky here is not quite black like on the Moon, but dark violet, for there is still a tiny drop of air left on Mercury.

The Sun is now on the horizon. Dark shadows stretch out from the hills and

rocks. The stones in the shade have begun to cool. You can touch them: the rocks are pleasantly warm like heated stoves.

Twenty hours pass. By our measurements on Earth, that's almost a day but here the Sun has just disappeared over the horizon. Its rim is still blazing like a dazzlingly bright "lighthouse" in the heart of the mountains. The plain is plunged into darkness.

In a few hours the "lighthouse" will also vanish. The peaks of the mountains around us are still shining, but they, too, will gradually cease to shine. It will become pitch-dark and get cold very quickly.

But don't worry, if Mercury, as it revolves, has taken us into the shade, we can go back into the light again, or rather, to the border between light and shade, and if we keep walking, we'll stay on this border all the time.

So this is what we'll do. We'll set off in our cross-country vehicle to catch up with the Sun.

Mercury turns slowly and we won't have to go very far each day. In half a year we will have travelled "round the world" without having felt excessively hot or cold. We will always be where it is "just right". We're clever, aren't we?

Don't be surprised how strange this planet is. Its orbit is slightly tilted to one side. The Sun is not in the middle but slightly to one side. In orbit Mercury draws closer to the Sun and then drifts away from it. When you look at the Sun from Mercury, it "swells" and burns more intensely and then "shrinks" and becomes cooler. In this "cold season" it is only about $-250-300^{\circ}\text{C}$ on Mercury!

But the most curious thing is that because of this "strange" orbit, the Sun

does not move at an even pace across Mercury's sky. Once every three months, it becomes slower and stops and moves backwards slightly, and only after standing still again as if to "regain its strength", it begins moving forwards again! How amazing! It's not like that on the Earth.

But these amazing features of Mercury turn out to be very convenient for us. In half a year of travelling we could rest twice and live in the same place for two weeks. True, when the Sun again set out across the sky, we had to travel 150-200 kilometres a day to keep up with it, but that was not difficult in our cross-country vehicle.

So now we have travelled round all the planet and seen everything. It's, of course, a pity that there are no living creatures on Mercury: only stones which are silent and motionless everywhere. It is a dead world like the Moon.



What Will We See on Venus?

Now let's visit Venus, the second nearest planet to the Sun.

Venus is not at all like Mercury which was surrounded by a transparent, rarified atmosphere. The bare stones are exposed to the blazing heat of the Sun or to the freezing cold. Nothing moved and there was absolute silence.

Everything is completely different here. Venus is "coated" by a very dense atmosphere which contains so many clouds that the planet seems to be completely wrapped in white cotton wool.

For hundreds of years astronomers puzzled about what was hidden behind this white blanket.

They all agreed that it must be very warm on Venus because it is nearer than us to the Sun.

They all realised that it's always dusk on Venus. If anyone lived there, "they" would always have storm-clouds above their heads. "They" would not even realise that the blue sky, the Sun and stars existed.

Scientists disagreed about everything else and made various suggestions.

Some asserted that Venus was a shoreless ocean and it was always raining. In a word, there was nothing but water.

Others objected that the water had long ago evaporated there. Venus was a burning-hot desert.

Others tried to reconcile these opposing views by claiming that everything there was most likely just the same as on the Earth. There were seas and deserts, mountains and forests and the vegetation was luxuriant and dense because of the heat. Amazing animals roamed the dense jungles and fantastic winged creatures flew below the dark clouds.



It was impossible to find out who was right. Only the white "cotton wool" sphere could be seen through a telescope.

Then radio-astronomers joined in the work. They had special telescopes which did not have to be looked through. They used a very sensitive radio and a special aerial which looked like a huge saucer. This aerial picked up radio-waves only on the side it was facing.

The radio-astronomers pointed their aerials in various directions. It appeared that radio-waves radiate from all warm objects. Of course, these waves do not carry words or music. If you catch them and feed them into a loud-speaker, you will only hear a rustling sound. But this rustling sound varies according to the object's temperature. Radio-astronomers learnt to distinguish these sounds and measure the objects' temperature from a distance.

And so radio-astronomers pointed their aerials at Venus, which picked up the radio-waves emitted by it, and showed that the clouds above Venus were cold but that a hard, almost red-hot surface lay below them!

Nobody believed the radio-astronomers! How could Venus be hotter than Mercury if it was further away from the Sun and, what's more, covered with clouds?

To find out what really was there once and for all, Soviet scientists and engineers decided to send automatic devices to Venus in powerful rockets. They were called "interplanetary automatic stations".

These stations took three months to fly to Venus.

The first two stations flew past, the third reached Venus but transmitted nothing, but the next stations brilliantly handled their job. They flew to the planet, penetrated its atmosphere, reduced speed, opened parachutes and slowly plunged into the mysterious clouds. While they descended they constantly relayed by radio

what they were "feeling" with their instruments.

The radio-astronomers were delighted! They had proved right! The stations' instruments showed that at the "bottom" of the ethereal ocean it was $+470^{\circ}\text{C}$ like in a blazing furnace.

The instruments relayed a lot of other interesting information. We learnt, for instance, that the heat on Venus is constant, day and night, in summer and winter, that the air there is dozens of times denser than ours and completely different in composition. It is poisonous for man.

After landing on the scorching soil, two stations even photographed the locality and by television sent us a close-up of the rocks on Venus.

And so now we are getting ready to land on this planet which is totally "unsuitable for life"!

But our spaceship is fireproof and very strong. Let's have a go!

We descend by parachute. It's frightening! We can't see where we're going to land. Clouds swirl under us. It'll be alright if there's a plain below us, but what if there's a sharp mountain peak or a bottomless precipice?

Our ship begins to sink into the clouds. Swirling white clouds surround us on all sides, rushing outside the portholes and closed down upon us. It has become dark.

The spaceship is swaying in the gusts of wind. The noise becomes constantly louder. Torn shreds of dark-grey clouds whirl around outside.

We have already been descending for half an hour. It has grown darker.

It hit the surface with a thud. The spaceship heeled over, slid somewhere, scraping its side against the rocks, thudded again and stopped.

Everything seems to be alright.

We put on our fireproof spacesuits and get out.

You have to admit that at first you feel rather frightened. The landscape is terribly



gloomy: a monotonous, toneless stony desert stretches out on all sides. There are no pools, bushes or signs of life, only motionless bare rocks. Above us there is an even dark-grey shroud of clouds. The light is dull and shadowless like a gloomy autumnal day on the Earth. The air is turbid and looks slightly sooty. The rocks in the distance blend into this grey gloom and the horizon is invisible.

But this isn't a dead world like the Moon or Mercury. Here, if you look around, you can see something moving. The air is slowly "flowing". You can't call it a wind. Our wind on the Earth is swift, gusty and capricious. Here you feel as if you are immersed in an enormous river which is flowing calmly and in the same direction all the time, and being chased by this gentle current small pebbles lazily trickle over the ground. Here and there in the mist you can see turbid mote-like streams slowly floating along. If you look into the distance, the stones sway gently like on the Earth when you look through the hot air above a bonfire. You keenly feel how incredibly dense the air is. When you step on the ground, a "mist" rises from underfoot and the current slowly carries it away, like silt on the bottom of a river on the Earth. It's difficult to stand: the current presses on you as if someone were resting the palm of his hand on you and gently, but insistently pushing you on. It's easy to walk with the current, but very difficult against it. You have to bend and look for where to put your feet. You tire quickly.

You still can't feel the heat in your suit. Only your feet, in spite of your boots' thick soles, already begin to feel hot.

We make our first experiment. We pour half a glass of water out of the flask we've brought with us. As if on a red-hot stove, it instantly scatters in crazy drops which hiss and splash along the rock, and rapidly evaporate in puffs

of steam. Within a few seconds the stone is dry.

We also have a piece of lead. We place it on a rock. The piece of grey metal melts almost at once and turns into a silvery pool.

Let's try and dig a hole. We turn over some large stones, break up the soil underneath, and remove it with a spade. With difficulty we dig down half a metre into the rocky soil. At the bottom of the hole, the piece of lead does not melt which means that the "burning hot planet" is only a thin layer on the surface of Venus and it is "cooler" inside the earth. There it is "only" about $+300^{\circ}\text{C}$.

Only a few minutes have passed since we left the spaceship but we're already feeling hot, even in our spacesuits.

We make our way back to the spaceship. Let's leave quickly!

We press a button and a balloon blows up above the ship and it tears away from the ground and begins to "float away".

Through the porthole you can see how it gradually gets lighter outside. Then the dazzlingly bright sunlight suddenly bursts into the cabin! Our ship races out of the clouds like a cork out of water! We're back in our habitual, cool, translucent and radiant space. How good it is here!

So that was Venus! But we won't give up hope yet.

It's not very cosy at the bottom of the ocean on the Earth, either. It's always cold and dark there, but no one forces the ocean dwellers to roam at the bottom. Dogs and cats, which need to walk on dry land, don't live there. Fish do. Many of them don't even know that the bottom exists because they have never been there. All their life they swim near to the surface.

The air above Venus is somewhat similar to the oceans on the Earth. Maybe, it is possible to live there, too, by swimming close to the surface?

It is not hot on the top of the clouds of Venus. The air there is about as dense

as on the surface of the Earth. We, of course, can't float in the air: we would sink. A bird can support itself with the help of its wings, but it has to rest sometimes. Where can it settle? Small fluffy insects are a completely different matter. They can float in this kind of air like motes without even flapping their wings.

It's quite possible that tiny "mote-like" creatures of this kind live above the clouds on Venus and it makes no difference to them that it's terribly hot below because they never go down there.

In short, Venus has to be studied. People will fly here, but won't descend to the bottom of ethereal ocean. Why should they? They will float above the clouds in balloons and airships. They will lower various fireproof instruments, sounding the planet's surface with radar-sets and will chart maps of Venus. Perhaps they will find high mountains whose summits are not so hot. Perhaps it is cool at the poles.

Some scientists have already suggested that Venus may be "set right" and made

suitable for habitation. To do so they suggest that a certain type of bacteria should be released into the atmosphere of Venus. Floating in the air, they will quickly multiply and disperse around all the planet and within a few years will change the composition of the air on Venus. The atmosphere will become transparent.

Then the planet's surface will gradually cool and rain will fall from the clouds in torrents. Rivers, lakes and seas will appear and people will sow seeds in the moistened soil. Forests will sprout and supply the air with oxygen, so that living creatures can breathe.

This will take hundreds of years but it's worth doing. A second "Earth" may be created.

And it's up to you to begin this work.

But meanwhile let's fly on. We'll speed past the third planet without stopping. It's our Earth, you see. We'll wave to our friends and fly straight to the fourth planet, Mars!



Are There Martians on Mars?

We are flying to Mars. It's still a long way off and looks like a small sandy-red sphere.

But very unlike Venus Mars is! It is coated in a light, translucent and cloudless atmosphere. Mars is not covered by anything, so all its features can be seen.

A bright white cap-like spot stands out on one side of it. This is one of the planet's two poles. The poles are the coldest places on every planet. It looks as if the cap is a thin layer of snow. In summer it melts and reappears in winter.

Most of Mars is light and reddish. Dark-grey spots can be seen against this background. When people first saw Mars through a telescope, they called these spots "seas", thinking they were seas full of water like ours on the Earth. However, the water would have shone in the sunlight, but nothing ever sparkled on Mars. People soon realised that the dark parts of the planet were completely dry.

However, they continued to be called "seas".

If you look closely, you can sometimes faintly see some strange dark lines as well as the large dark spots on Mars. They are thin and straight like taut threads, and spread out in different directions like cracks in a pot which is broken or about to break.

Scientists called these mysterious stripes "canals", although they knew that if the "seas" were dry, the "canals" could not be filled with water, especially as they were dozens of kilometres wide!

They noticed that both the "seas" and "canals" on Mars were pale in winter. In spring they became darker as if they had filled with water and sometimes they seemed to become greenish. In the autumn they became pale again.

But the same happens to our forests on Earth. In winter the trees are bare. If at this time you look down at a forest from a plane, for instance, it looks grey,

pale and transparent. In summer, however, the trees are covered with green foliage and the forest becomes darker.

That's why many people began to think that the dark spots on Mars were forests and that the places where they grew were humid lowlands.

It was hard not to believe this as the Martian "forests" began to grow darker just as the snow cap at the pole began to melt. They first grew darker by the cap and then gradually grew darker further and further away, as if the melted snow flowed round the planet, and brought life to the vegetation.

But how does it flow? In "canals"? But why are these "canals" so straight?

There are hardly any straight lines in nature. Rivers meander and the seashores are carved by bays. Mountains come in all shapes and sizes.

But man likes to draw straight lines. He builds straight dams because they are cheaper and cuts straight paths through the forests because they are shorter. Man is a rational being and makes things as best as he can.

And so, some scientists decided that the straight Martian "canals" had been constructed by rational beings. They said that there was little water on Mars. All its vast bright spots were dry sands. It had no seas, lakes or rivers. It didn't even rain there. But how can you live without water? That's why, as the snow cap melts at the pole in spring, the Martians carefully collect the drops of precious moisture and channel the water through some kind of pipes to plantations, towns, and warm parts of the planet.

The pipes were constructed in a straight line so that the water would flow faster. The Martians' irrigated vegetable plots, fields and gardens were situated along these pipelines and barren deserts stretched out beyond them. There was not enough water for the whole planet.

From afar these cultivated regions, threaded onto the pipeline like beads

on a string, look like mysterious dark stripes.

How beautiful all this seems to the imagination! Martian cities! Martian palaces! Martian gardens in bloom!

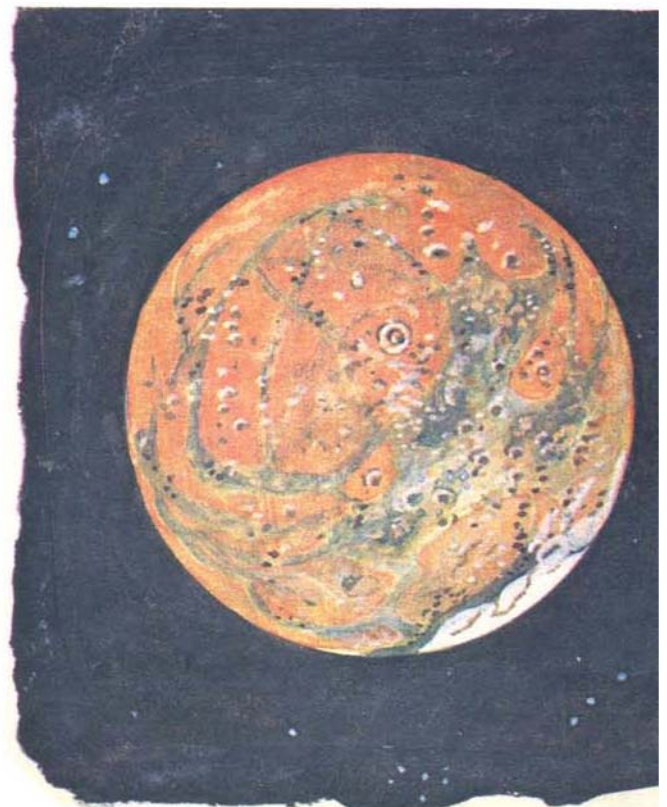
But as we approach Mars, the images we have conjured shatter one after the other.

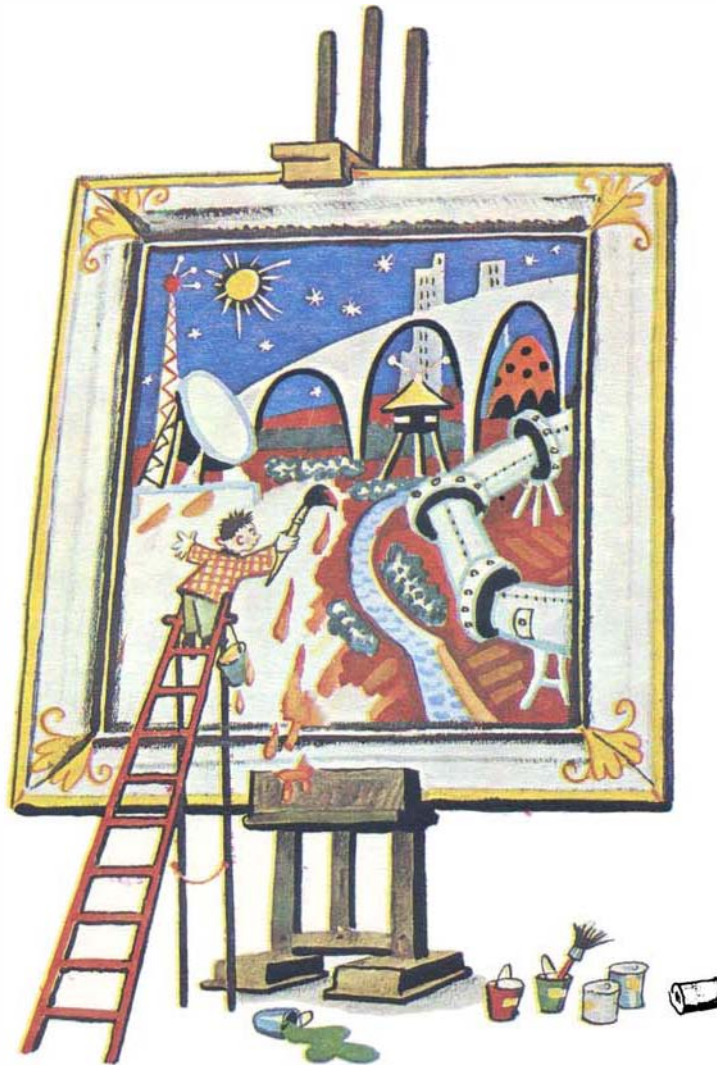
Almost all the light places on the planet turned out to be barren plains, as we supposed. True, here and there are pitted round depressions, similar to Moon craters. The "seas", however turned out to be quite different from what was expected. They were not "humid lowlands overgrown by forests" but almost all barren mountain regions.

Strangely enough the "canals" did not become any clearer as we approached: the same mountains, craters and ravines as everywhere else appeared in their place.

Why's this? Why are the mountains darker than the plains? Why do they become even darker in spring? Where have the "canals", which we thought would be so interesting, vanished to?

As we fly closer, the "vital secrets" of Mars become a little clearer.





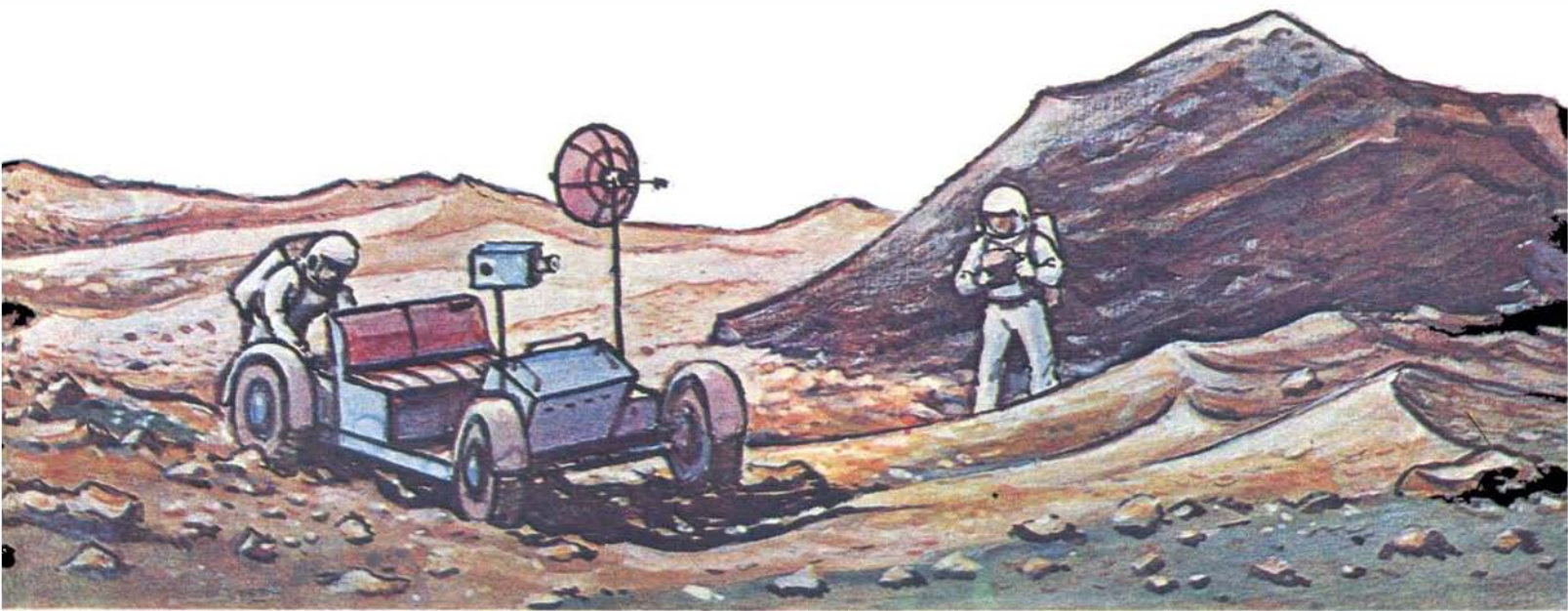
There is a lot of sand and dust on Mars. They, as on the Earth, are lighter than the bare rocks.

There are also strong winds on Mars which blow the dust from all the projecting parts of the planet, i.e., from the mountains to the lowlands. The mountains are always swept and clean and, therefore, dark. The plains at their foot, on the other hand, are constantly plagued by sand and dust and, therefore, light.

In spring the snow thaws at the pole,

humid winds blow and “spring-clean” the planet. Afterwards, the mountains look “aired” and even darker. It’s all very simple and has absolutely nothing to do with forests.

Well, what about the “canals”? They were obviously an optical illusion. The ravines, craters, mountains and ridges are scattered about Mars higgledy-piggledy. In some places they are denser than in others. And in some places three or four craters happen to be lying in a row, mountain ridges stretch out almost in



a straight line, and huge ravines cut through the desert in arrow-straight lines. From afar all these places seem to us like straight dark stripes.

But so far there is no sign of any of the rational Martians' constructions, and it's likely that they just don't exist.

But we still think that Mars is not a lifeless planet like the Moon, Mercury or Venus. The latter are hopelessly dry like huge stones heated in a furnace. No kind of life is possible without water. Mars, however, is very slightly "humid".

Several interplanetary automatic stations have been near Mars before us. A few of them have even landed on its surface. They have found out a great deal.

The white caps at the poles of Mars

turned out to consist mainly of "dry ice" which on Earth we pack in ice-cream boxes. They also contain ordinary snow-frozen water. In spring it thaws and evaporates. The moisture drifts into the air and is carried by the winds to the hot parts of the planet where it falls on the frozen ground in the form of white hoar-frost at night. In the rays of the morning Sun the hoar-frost thaws and the ground becomes moist for a few minutes. Living beings in the form of plants or insects, would then be able to drink their fill.

It's most interesting that when they were examining Mars close-up, the automatic devices found and photographed the beds of dried-up rivers. Does that

mean that torrents of water gushed along on Mars not so long ago? Where did it all go to then? It probably seeped into the ground and froze? After all, it's cold on Mars.

But the automatic machines also discovered "heaters" which could warm the frozen water in the ground. They found volcanoes on Mars. They have become extinct and no longer erupt. However, heat still rises from the depths of the planet around them and the frozen earth could thaw. And if a volcano begins to erupt and red-hot lava pours from it, everything around will warm up, and water will gush in torrents.

That means living creatures on Mars could quite easily get water for themselves from the air above and the soil below.

That's why we think that there still must be "someone" on Mars. But who? Of course, it's very unlikely that there are "people", but there well may be plants and small living creatures.

Where could they live? Where should they be looked for?

On Earth living creatures live on the planet's surface where they feel happy and there's plenty of heat and water. It would seem better to live underground on Mars and only surface in the volcano craters where it is warmer and more humid.

And now we have come to the most interesting part. Flying over the Martian mountains and plains, the automatic devices made a series of colour photographs. The bottom of some craters are greenish on them! Perhaps this is the "life on Mars"? Perhaps we can already see a "carpet" of green foliage, some amazing "fairy-tale" Martian plants among which strange small beasts, unknown to men, swarm?

So, we have arrived at Mars. We choose an even place and land.

The sky is cloudless and deep purple like on Mercury, and like there, if you shield yourself from the bright light,

you can see the stars in the daytime.

The Sun is very small in the sky: about one and a half times smaller than we are used to seeing it on Earth. That's why it hardly emits any warmth here.

It's generally cool here. It is only about $+10^{\circ}\text{C}$ in the Sun. Towards the evening it gets cold quickly. At night it will be terribly cold: -100°C . What's more, we're in the planet's warmest region.

It's deadly silent.

What's that? The desert begins to rustle and whistle. A hurricane has arrived! And what a hurricane! All the sand in the desert seems to have been whipped into the air and is rushing along like a dark yellow cloud. All the sky is covered by this cloud of dust. The Sun grows dark. Dusk has descended.

We take cover under a rock and wait for the storm to end.

It dies down a few hours later. All around there are high sand-drifts.

It's dangerous to walk here in the desert!

We look around. On one side vast picturesque sand-hills stretch out to the horizon. On the other, there are beautiful rocky mountains nearby.

We set off on foot towards these mountains.

We are, of course, in spacesuits. We have to get our supply of air from cylinders. The local air does not have the same composition and it is a hundred times more rarified than ours.

No birds or insects could fly in this rarified air. You can only crawl, run and jump on Mars.

And if there really are Martians, they certainly don't have wings.

How differently people have imagined what Martians are like!

Some used to say that they were most likely very small and similar to ants.

Others imagined them as fantastic octopuses with tentacles.

Others thought that they must be like people.

But what if they really do exist?

Whatever they're like, they're probably very interested in the Earth. And if we meet them, we'll take one with us and show him our planet.

True, he would immediately become limp with the heat on Earth. We would have to put him in a small fridge with a window and wheel him around.

When he saw the sea on Earth through this window, he would most likely cry with envy. You see, this is the same as it is for us to see mountains made of cakes and rivers of milk and honey. On Mars water is probably sold in bottles as a thing of value, but on Earth we have oceans of water and it costs nothing.

Our Martian would probably admire the clouds on Earth for days on end. You see, they've got nothing like them. And our clouds are sometimes so beautiful, especially at sunrise and sunset!

We continue walking towards the moun-

tains. It's a long way. Our feet sink in the crumbly sand.

Something gleams green on the mountain slopes as if the rocks were overgrown by moss in places.

We're very close to the cliffs now. What we took for moss at a distance, now looks like low shrubs.

And suddenly under the bushes something moved! Some living creature jumped towards us and then disappeared under the bushes! There're certainly a lot of "them"! They've spotted us! They're coming towards us!

Who are they?

We won't say any more. You realise that no one has been on Mars yet. You yourselves can fantasise better about life on this planet. Imagine what you like. That'll be more interesting. And when you've grown up, fly to Mars and see who was right.



What Are Jupiter and Saturn Like?

We have been able to land on Mercury, Venus and Mars. Although it wasn't very pleasant, at least we could stand on something and look around.

But it's quite impossible to land on Jupiter and Saturn.

These planets consist of practically nothing but clouds.

Jupiter, for instance, is not really such a big planet as it seems, but it sits inside an enormous sphere of cloud like a stone inside a cherry. We can only see this

sphere of cloud and none of the planet itself and we marvel how big Jupiter is. In fact, only its wrapping is large.

But Jupiter has fourteen satellites, that is, fourteen moons! Some of them are very big. Two of them are the same size as our Moon and two are even as big as Mercury.

We will land on the satellite nearest to Jupiter.

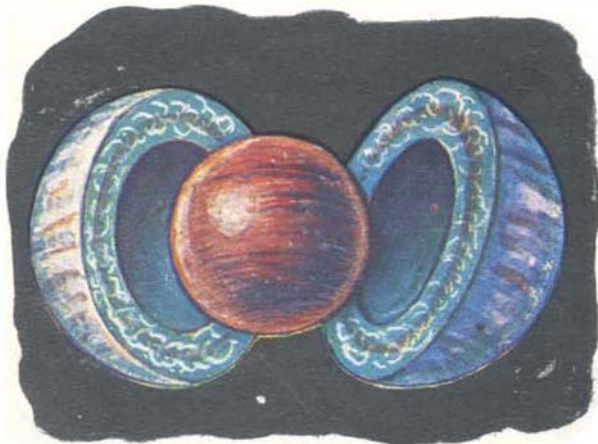
Look how beautiful it is! Jupiter is a vast nebulous sphere which is as big as half the sky.

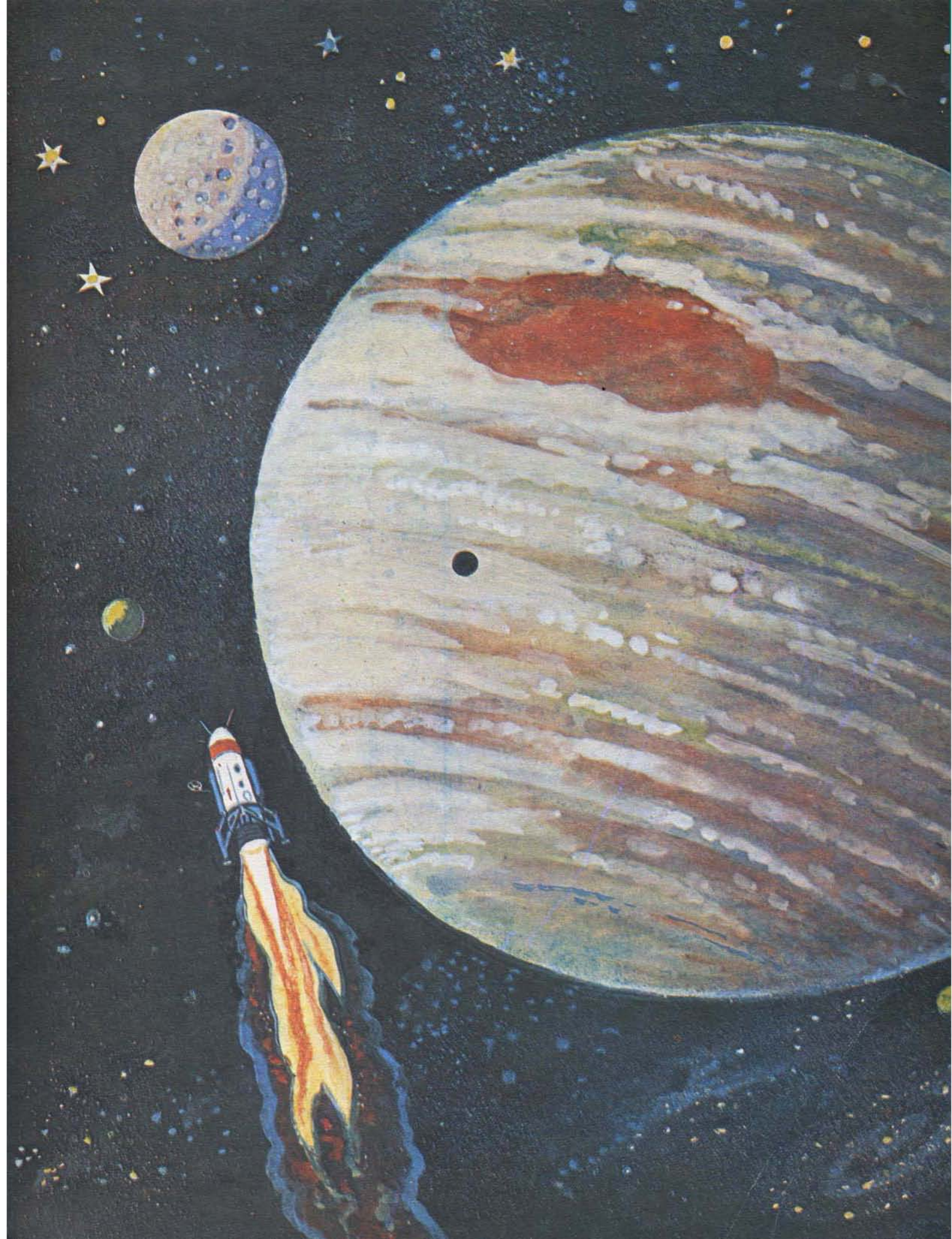
And how fast it's spinning! It turns round in ten hours.

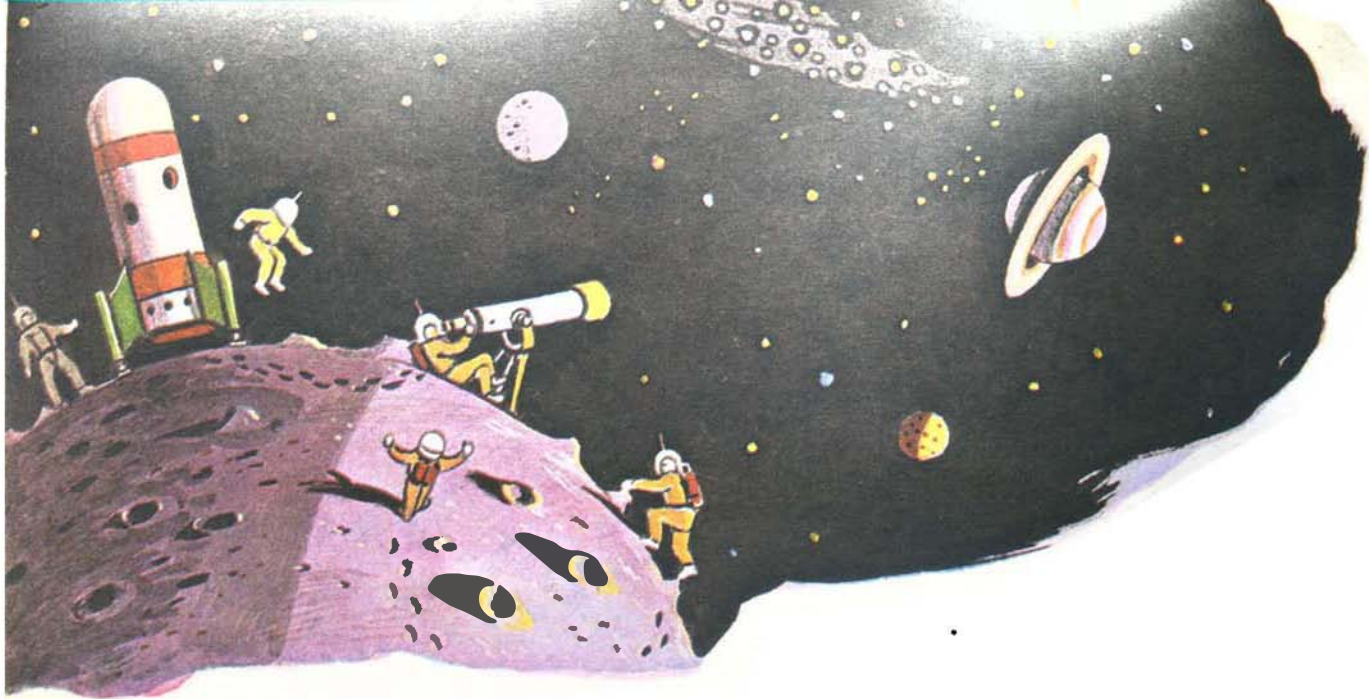
Because it's turning so fast, Jupiter's clouds lie in stripes along its equator like streams on the surface of a rapid river.

These streams of clouds are constantly outstripping each other, swirling and changing shape.

A strange red spot can sometimes be seen in one place among the white stripes on Jupiter. It looks as if a red mist is rising from the depths like silt from a river-bed.







A crimson cloud draws the streams of white clouds apart and swirls, glowing and fading in turns.

Perhaps a volcano is erupting, dying down and then flaring with new strength at the bottom of the nebulous ocean?

One day you'll solve this mystery of Jupiter.

Let's fly on.

The next planet is Saturn which is very like Jupiter: it is a vast nebulous sphere with a hard nucleus at the centre.

Saturn is surrounded by a ring. That's why it looks very decorative.

Only don't think that Saturn's ring is solid like the rim of a hat. No, it is made of tiny fragments which speed round the planet.

In our spaceship we can fly through this ring, just like through pelting hail. The small grains only beat against the walls of the spaceship.

This ring is about 20 kilometres wide and the ship flies through it in a minute.

Saturn is certainly the most beautiful planet in the Solar System.

The remaining planets are not so interesting. Uran and Neptune are like Jupiter, and Pluto is a frozen, barren planet which is terribly far away from the Sun. It is so far away that it revolves around the Sun once every 250 years! From there the Sun only seems like a small, bright star and, of course, emits no heat at all.

Pluto is the last planet in our Solar System.

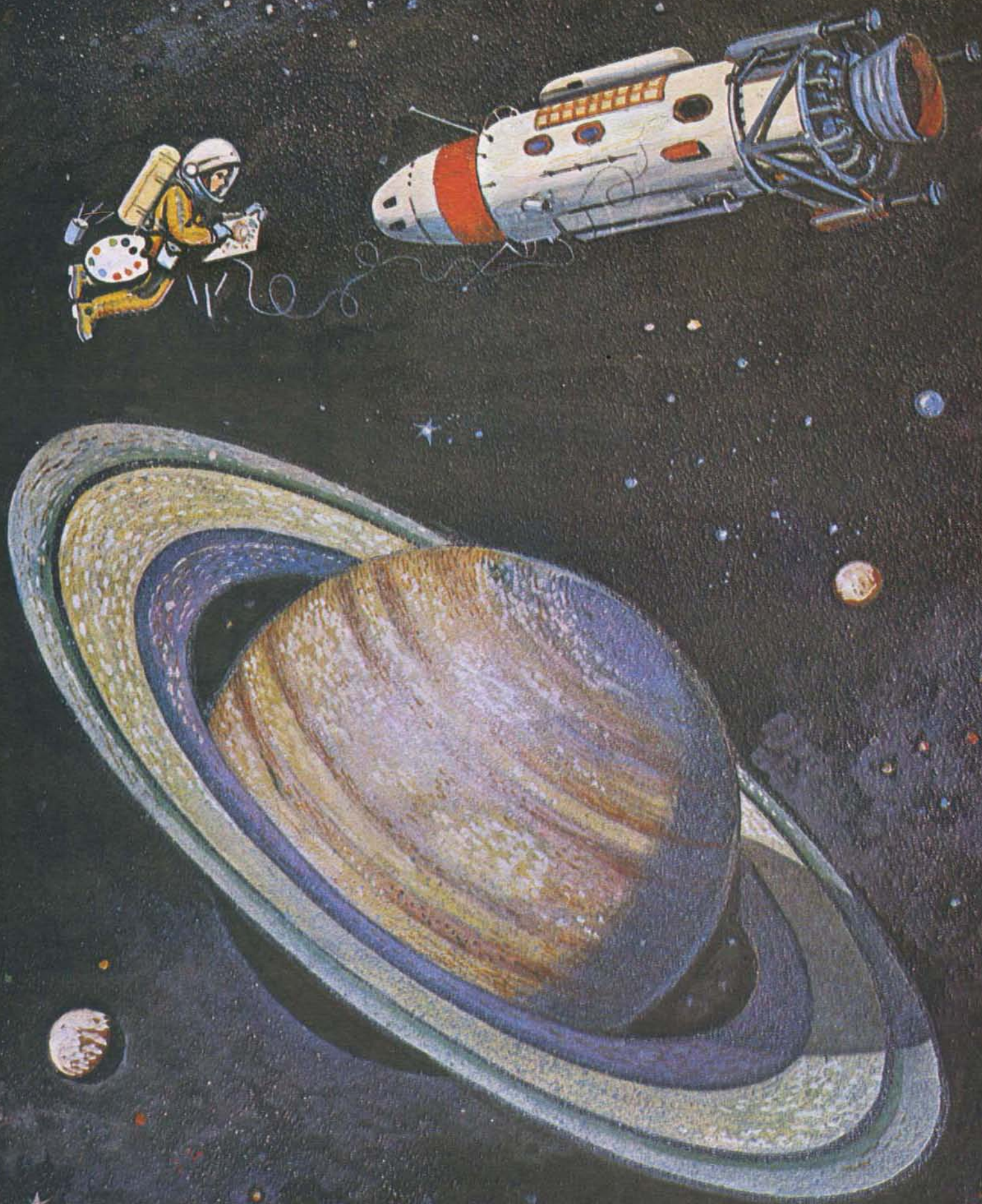
Empty space stretches out from Pluto to the stars.

But each star is a Sun.

And most likely many of these distant suns have their own planets.

Some of them are probably like our Earth and they are inhabited by people who are, perhaps, similar to us.

But this is so far away and we still know so little about the neighbouring planets!





When Will People Find Out More About the Planets?

It's difficult to study the planets just by looking at them through a telescope from the Earth. People have always longed to go there themselves, to touch everything with their own hands, so to speak, see it with their own eyes and listen to everything for themselves.

It would be so interesting to find out if there were some kind of plants, animals, or life on the other planets. People are especially interested in meeting some intelligent beings somewhere else.

What will they be like? Will they be like us or not?

Planets are small islands in vast, boundless space. They are separated by tens and hundreds of million kilometres. How can you get from one planet to another? In what?

You already know that an airship or plane are not suitable for this. An airship floats in air and a plane is supported by air. They can only rise to an altitude where there is still sufficiently dense air and a sufficiently dense atmosphere. When the atmosphere thins out completely and ends you can no longer fly. You cannot climb a tree higher than the tree itself.

You only cover the very beginning of the journey to the planets in the atmosphere and the rest of the journey is through empty space.

But you can jump across empty space, just as you can across a ditch.

For a long time people did not know how to do this: how to gather speed and push off hard enough to reach the other planets. Then the outstanding Russian scientist Konstantin Tsiolkovsky declared that the planets could only be reached by rocket.

Rockets consume a vast amount of fuel in a few minutes. With a deafening roar fire bursts out underneath and with incredible force thrusts the rocket upwards.

Even a small space-rocket is as powerful as several thousand diesel engines which pull the heaviest trains along the railways!

With this fantastic power the heavy rocket easily breaks away from the Earth and very quickly gathers speed. In a few minutes it manages to pass through the clouds, leave the atmosphere and enter space. Then it is totally free to accelerate to a crazy speed. It is now flying fifty times

faster than our latest TU-154 passenger jet!

Once it has left the Earth with incredible speed, the rocket grows quieter. It has made its "leap" and will now fly through empty space like a stone across a ravine.

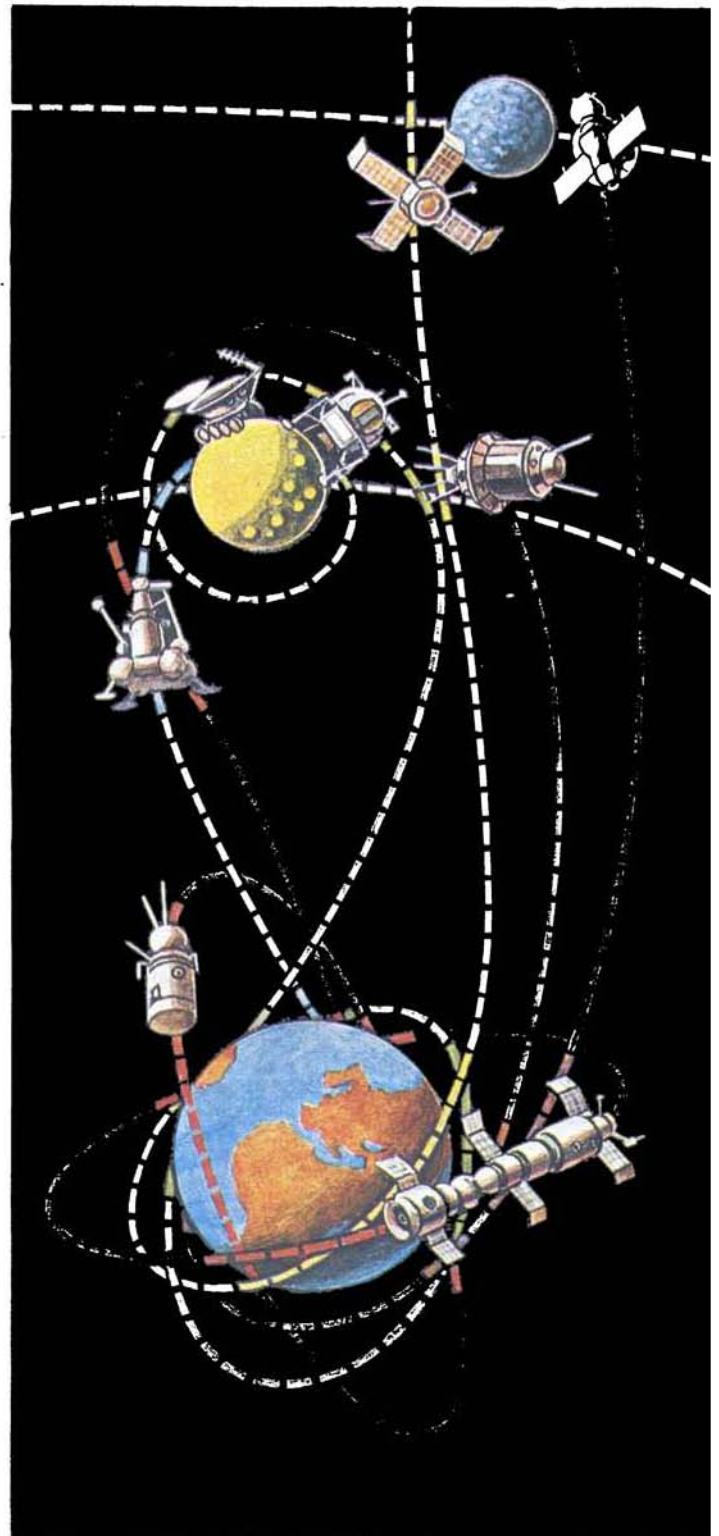
The stone does not fly straight but in an arc, heading for the Earth. The rocket also does not fly straight in space, but turns towards the Sun. That's why the rocket has to be launched in such a way that as it turns, it will finally reach its destination. Don't forget that the planet it's going to isn't standing still, either. It is flying round the Sun which means that the rocket has to be sent into space in such a way that in a few months time it will meet the planet.

This is highly complicated but people have managed to do it. Only two decades ago, in 1957, the Earth's first artificial satellite was launched into space from the Soviet launching pad, Baikonur. In 1959 man was already heading towards the Moon: the Soviet station *Luna-2* delivered a pennant there. Since then Soviet and American interplanetary automatic stations have explored cosmic space one after the other. In 18 years they have been near the Moon, Mercury, Venus, Mars and Jupiter. They have landed on the Moon, Venus and Mars. Soil samples have been taken from the Moon and spectacular Soviet *Lunokhods* have wandered about the Moon's surface for months at a time.

But this still does not mean that man can now get into a rocket and set off, say, for Mars.

Man is a very delicate and fragile being. It requires the same amount of care to launch him into space as to send a valuable live fish to a zoo on the other side of the world. It is put in a jar of water, fed and carefully watched so that the water does not splash, overheat or become polluted.

A spaceship is a "jar of air" for man and more trouble is involved with a person in this "jar" than with a fish.





That's why from the very start scientists tried only to send a man into space in extreme cases and automatic devices whenever possible.

Automatic devices are sent to explore space. Man cannot be sent until all the necessary information is available. Why take unnecessary risk? And so, only after automatic devices have reconnoitred an area, can man be launched into space if needs be.

On April 12, 1961, the first man was launched into space. He was the Soviet cosmonaut Yuri Gagarin.

On July 21, 1969, the first people set foot on the Moon.

Docking has been mastered in space without which distant space journeys are impossible.

The Soviet *Salyuts*, American *Skylab* and Soviet-American *Soyuz-Apollo* stations have been launched into orbit round the Earth. Among other projects, the cosmonauts are working out how to make

distant flights on stations of this kind.

All these are preparatory stages for a decisive "storming" of the planets.

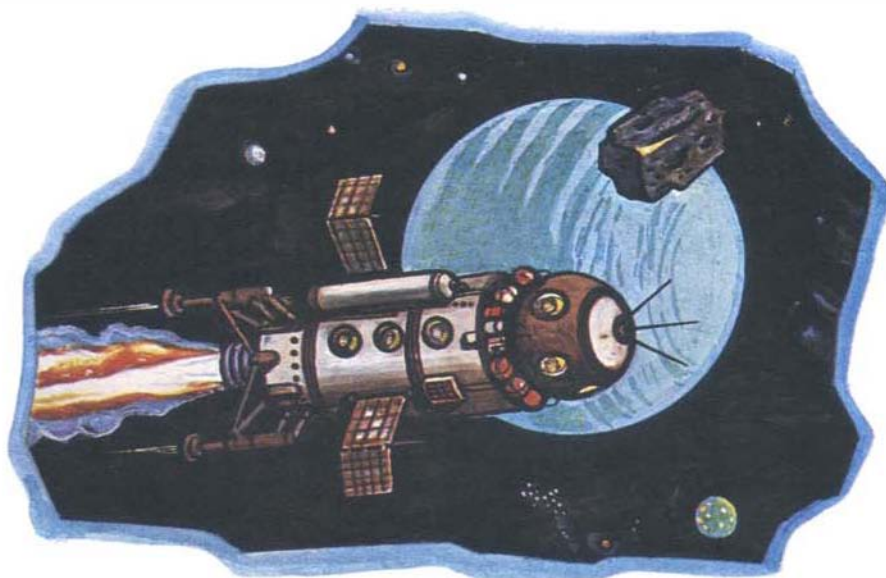
In the near future most varied and increasingly complex interplanetary automatic stations will fly to Mercury, Venus, Mars and Jupiter, and carry out reconnaissance work. When man knows exactly what awaits him, he, too, will fly to the planets.

But the first visit to each planet will once mark the beginning of a proper, thorough study of it. After all, we have already studied our own Earth for thousands of years and still don't know everything about it and this is even truer of other worlds.

Much time is needed to study them properly. Hundreds of expeditions and thousands of explorers will fly to them for many years to come.

You can be among them if you wish.

It's wonderful that man is incredibly inquisitive!



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Павел Клушанцев
О ЧЕМ РАССКАЗАЛ ТЕЛЕСКОП
На английском языке

